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ARMSED, A RUNOFF AND SEDIMENT YIELD MODEL FOR ARMY TRAINING LAND WATERSHED MANAGEMENT VOLUME II: PROGRAM DOCUMENTATION

by
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Army land managers and environmental planners must estimate runoff and sediment yield from small, ungaged watersheds on Army training lands to assess the condition of the lands and to evaluate alternative erosion control plans. The U.S. Army Construction Engineering Research Laboratory (USACERL) developed the Army multiple watershed storm water and sediment runoff (ARMSED) simulation model, which is based on the MULTSED model and has been adapted for Army use.

ARMSED is a single event, distributed, deterministic simulation model that operates on MS-DOS compatible microcomputers with 512 K RAM. A 10-megabyte hard disk is recommended.

This report provides guidance and documentation for ARMSED users. Volume I contains guidance for selecting and estimating the parameters and values needed as input for the model. Volume II describes the various subroutines of ARMSED and the modifications that have been made to arrive at the current version. As the user base for ARMSED expands, the model will be updated and modified to incorporate new data ideas.

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FOREWORD

This research was conducted for the U.S. Army Engineering and Housing Support Center (USAEHSC) under Project 4A162720A896, "Environmental Quality Technology"; Technical Area A, "Installation Environmental Management"; Work Unit 097, "Physical/Structural Erosion Control for Training Land Rehabilitation." The USAEHSC Technical Monitor was Donald Bandel, CEHSC-FN.

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COL Carl O. Magnell is Commander and Director of USACERL and Dr. L. R. Shaffer is Technical Director.

CONTENTS

ARMSED, A RUNOFF AND SEDIMENT YIELD MODEL FOR ARMY TRAINING LAND WATERSHED MANAGEMENT VOLUME II: PROGRAM DOCUMENTATION

1 INTRODUCTION

Background

Army land managers and environmental planners must estimate runoff and sediment yield from small, ungaged watersheds on Army training lands. These estimates are needed to help assess the condition of the lands and to evaluate alternative erosion control plans. Because estimating runoff and sediment yield is a difficult hydrologic task, mathematical computer models can be an important part of the process. The U.S. Army Construction Engineering Research Laboratory (USACERL) developed the Army multiple watershed storm water and sediment runoff (ARMSED) simulation model, which is based on the MULTSED model developed at Colorado State University. USACERL conducted studies of MULTSED to test the formulation and sensitivity of the model.[1] ARMSED is an Army tailored adaptation of MULTSED.

ARMSED is a single event, distributed, deterministic simulation model that operates on MS-DOS compatible microcomputers with 512K RAM. A 10-megabyte hard disk is recommended.

Objective

This report provides documentation and guidance to ARMSED users. Volume II focuses on the structure of the current model, a description of the different subroutines (processes), modifications made to the model, and recognized limitations and problems one may encounter when applying the model. Volume I is a guide for estimating the input parameters used in ARMSED.

Approach

This volume describes the current state of the ARMSED model. A description of the model structure and components is given and each subroutine is described. Modifications from the MULTSED model are explained and limitations are described.

Mode of Technology Transfer

The ARMSED program is available on a 5¼-in. floppy disk and can be obtained by contacting Mr. Robert E. Riggins at USACERL-EN, P. O. Box 4005, Champaign, IL 61820-1305. Telephone: commercial 217/373-7234, or toll-free 800/USA-CERL (outside Illinois), 800/252-7122 (within Illinois). ARMSED will be fielded under the Integrated Training Area Management Program as part of the Maintenance and Scheduling Support System. As the user base expands, the model will be updated and modified to incorporate new data and ideas.

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[1] H. G. Wenzel, Jr. and C. S. Melching, *An Evaluation of the MULTSED Simulation Model to Predict Sediment Yield*, Technical Report N-87/27/ADA185615 (U.S. Army Construction Engineering Research Laboratory [USACERL], September 1987).

2 MODEL STRUCTURE AND SUBMODELS

Structure

The original version of MULTSED contained three submodels: MSED1, MSED2, and MSED3. MSED1 processed data on upland watersheds and planes and MSED2 sorted/ordered the output from MSED1 for use in MSED3. MSED3 processed data on channel routing. ARMSED maintains this modular structure, but MSED2 and MSED3 have been merged into one submodel called MSED3. Current listings for the ARMSED submodels are in Appendix A.

MSED1

MSED1 is the primary submodel of ARMSED. The basic building blocks of the submodel are referred to as either watershed units or plane units. Watershed units consist of a single channel and two contributing overland flow planes, one on either side of the channel. Watershed units are normally located at the upper reaches or on the perimeter of a large drainage basin. They are unique because the planes and the channel all have a "no-flow boundary" condition at the upstream (upslope) end. Plane units that are part of a watershed unit can be modeled separately. Plane units not associated with a watershed unit typically contribute to a channel segment that does not have a no-flow boundary condition. The channel is not a part of the plane and must be analyzed using the processes in MSED3. Combinations of watershed and plane units are used to represent the geometry and other characteristics of the drainage basin under study. The MSED1 submodel contains a main program, 15 subroutines, and 1 function that are discussed below.

Program MULTSED1

This is the main program for the MSED1 submodel. In this program, the name of the input file is requested, some indexing information is read from the data file, subroutines ANAWAT and OUT are called, output information is written to files 7 and 8 for later use in MSED2, and some conversions are made to the data for input and output needs. The program contains labeled common block SED. The output information contained in files 7 and 8 is the unit id = ISEG (variable name in the submodel), sediment yields = YIELD (for each sediment size fraction = NSED), total water yield = QT, and hydrograph values at each time step = QDUM. The information is written to file 7 for plane units, and to file 8 for watershed units.

Subroutine ANAWAT

This is the primary subroutine of the MSED1 submodel. In this subroutine, INPUT, TEMP, INTRCP, CUTOFF, FORWRD, BACK, TRANSP, QLAT, and RESIST are called. The subroutine initializes the output variables and converts runoff and yield values for output. The rainfall excess used in routing is EXCES. Labeled common blocks are COVER, DEPTH, and SED.

Subroutine INPUT

This subroutine reads the remainder of the input file that was initially accessed in Program MULTSED1. The information includes all of the geometric, soils, sediment, cover, and rainfall data for the response units. (The structure and contents of the input file are presented in Appendix B.) Data on hydraulic conductivity and rainfall rate are

converted to inches per minute. The overland flow length is reduced by the fraction of depression storage on the plane. The representative grain sizes to be used in the sediment transport computations are calculated as the geometric mean between the successive sizes of the grain size distribution curve that was read into the model. The representative fraction is calculated as the difference in cumulative fraction between successive sizes. Labeled common blocks are COVER, SOIL, SED, and VAR1.

Subroutine TEMP

This subroutine is used to select a kinematic viscosity of water for the temperature that was read into the submodel. The viscosity is then used to adjust the hydraulic conductivity for the soil. Labeled common block is SOIL.

Subroutine INTRCP

This subroutine is used to subtract cover interception from the rainfall data and readjust the rainfall hyetograph as necessary. If interception is present, the duration of the rainfall is reduced to satisfy the interception depth and not the intensity. Therefore, portions, or all of the beginning hyetograph increments may be eliminated to satisfy intercept. Labeled common block is COVER. A warning is printed if all of the rainfall is intercepted.

Subroutine CUTOFF

This subroutine is used to compute the rainfall excess array, EXCES. A modified Green-Ampt infiltration equation is used, which is called as function DF. The subroutine computes the infiltration on a time step or incremental basis. For time periods beyond the last rainfall increment, rainfall excess can be considered equal to zero or equal to some infiltration rate. Currently, the rainfall excess is set to zero for those times. If an infiltration rate is needed to better describe the process taking place (i.e., continued losses), then a negative rate must be used instead of zero. For most practical problems, this rate occurs so late in the storm that using a value other than zero has little effect on the hydrograph or sediment yield. Labeled common blocks are SOIL and COVER.

Function DF

This function is accessed from subroutine CUTOFF. Given the depth of infiltrated water from the previous time step (hyetograph increment) and soil hydraulic properties, the function returns the maximum depth of water that could be infiltrated in the current time period. When passed back to CUTOFF, this value is compared with the rainfall depth in the increment and the lesser of the two is the amount that is infiltrated during the time period. If the rainfall depth is greater than the infiltration depth, then water (EXCES) is available for routing. If all the rainfall excess has been infiltrated, a warning message is printed.

Subroutine FORWRD

This subroutine is used to calculate the characteristics downslope (or downstream, in the case of a channel). A characteristic can be thought of as an open-top container that moves down the slope collecting rainfall (excess) until it reaches the downstream boundary and empties the water it has collected. There are an infinite number of characteristics traveling at any one time, so calculating values for each one is not practical. Because the rainfall excess is represented as a hyetograph, each characteristic is assumed to begin at the start of a hyetograph increment. The characteristic is

propagated in a piecewise manner across the plane (channel) for each time increment. If the characteristic goes beyond the downstream boundary in some time increment, the correct time of arrival for the characteristic is calculated from the last computed position of the characteristic. If the rainfall excess ends before a characteristic reaches the downslope boundary, then the characteristic is extended to the boundary as a straight line when the loss rate (refer to CUTOFF) has been set to zero. Otherwise the characteristic is propagated with a negative excess (loss). When the time increment reaches the end of the hyetograph, subroutine STOP is called to compute the arrival times of the characteristics that originate after excess ceases.

Subroutine STOP

Similar to subroutine FORWRD, and used in conjunction with FORWRD, this subroutine calculates the arrival times of those characteristics that begin after the rainfall excess ceases. Those characteristics represent the final bounding characteristic (zero value) for the hydrograph (i.e., no more flow).

Subroutine BACK

This subroutine can be thought of as the reverse of subroutine FORWRD. In this subroutine, characteristics begin at the downslope boundary and are propagated upslope to intersect the no-flow boundary. This propagation is necessary because the characteristics propagated downslope do not arrive at equal time intervals. If an equally timed incremental hydrograph is desired, characteristics must be propagated upslope to determine the corresponding starting time. The starting time for a given characteristic is bounded by the starting times previously selected in subroutine FORWRD. The subroutine uses a second order Newton's method to quickly estimate the appropriate staring time. (See Eggert[2] for a recent presentation of the technique.) Subroutine ITEGR is called to determine the excess between the new beginning times for the upslope propagated (backshot) characteristics. Subroutine INDX is called to determine the bounding times on the previously computed FORWRD propagated characteristics. Labeled common block is DEPTH. The time adjusted discharge values are contained in array QOUT.

Subroutine ITEGR

This subroutine is used to find the rainfall excess (plane) or lateral inflow (channel) that forms the upslope (upstream) boundary condition for the BACK subroutine. If the backshot characteristics bound a change in the excess hyetograph rate, the new corresponding excess is time weighted (i.e., total depth is used).

Subroutine INDX

This subroutine is used to find the bounding characteristic time for the BACK subroutine. Iteration is used until the correct time is found.

[2]K. G. Eggert, "Upstream Calculation of Characteristics for Kinematic Wave Routing," *Journal of Hydraulic Engineering*, Vol 113, No. 6 (American Society of Civil Engineers [ASCE], June 1987).

Subroutine QLAT

This subroutine is only used when a channel in a watershed unit is routed. Overland flow from the contributing planes is summed for each time increment. The contributing planes had previously been routed and adjusted with BACK. The lateral inflow then serves the same purpose as the rainfall excess in subroutines FORWRD and BACK. The adjusted lateral inflows are in array QLT.

Subroutine RESIST

This subroutine is called to calculate kinematic wave routing parameters using Manning's equation. The original MSED1 contained both Manning's and Chezy's equations. Because Chezy's equation is so rarely used, it was removed from the current version.

Subroutine TRANSP

This subroutine represents a major consolidation of the sediment yield estimation routines for the plane and the channel units that were in the original MULTSED version. When transport is called by program MULTSED1, a parameter (ID) is passed that tells the subroutine to determine the yield using the hydraulics and other characteristics of a plane (ID=0 or 1) or of a channel (ID=2). The subroutine uses the Meyer-Peter, Mueller bed load and the Einstein suspended load equations to determine the sediment transport capacity. Sediment supply in a plane comes from raindrop splash, loose sediment, and overland flow detachment. For a channel, sediment supply comes from the contributing planes and detachment by channel flow. Sediment yield is the lesser of the two; supply or transport capacity. Transport and yield are determined for each sediment size fraction specified by the input data. The Einstein equation has not been modified from the original version as suggested by Melching and Wenzel[3] because the original derivation for the model was evaluated and found to be adequate. Labeled common blocks are DEPTH, SED, SOIL, and COVER.

Subroutine POWER

This subroutine is used to calculate the necessary integrals for the Einstein suspended load equation. The integrals can be expanded and integrated as an infinite series of terms. These terms are iterated until the error between two successive terms reaches 0.001.

Subroutine OUT

This subroutine controls printing the results to the CRT and to a disk file called SCREEN1.OUT. Sediment yields are in array YIELD and discharge rates are in array Q.

MSED2

This submodel has been merged with MSED3 as a subroutine because the only time it is needed is when MSED3 is run. It is described in the following section.

[3]C. S. Melching and H. G. Wenzel, "Calibrating Procedure and Improvements in MULTSED," *Hydraulic Engineering Series No. 38* (Department of Civil Engineering, University of Illinois, July 1985).

MSED3

This submodel is used to determine water and sediment transport through a channel system (one or more channels) that is supplied by the watershed and plane units and any upstream channels or small reservoirs. The submodel contains several subroutines that are similar, if not identical, to those used in MSED1. There are a total of 18 subroutines in this submodel. The submodel uses a finite difference numerical solution to solve the continuity and momentum equations for water flow in a channel that has a nonzero upstream inflow. The analytical solution used in MSED1 is not appropriate here because of this nonzero condition. Sediment in the channel is routed uncoupled from the water (i.e., erosion and deposition do not affect the water flow) using the finite difference form of the continuity equation for sediment. Each channel is subdivided into five equal longitudinal sections for the routing parts of the model. The following sections describe the different subroutines in more detail.

Program MULTSED3

This is the main driving program for the MSED3 submodel. This program interactively queries the user for the name of the data file. Subroutines MSED2, DATA1, TEMP, INITL, and ROUTE are called from this program. Output files SCREEN3.OUT and MSED11.OUT are opened. SCREEN3.OUT receives the CRT display output and MSED11.OUT receives detailed information about each channel segment that was modeled. The CRT and SCREEN3.OUT only have information about the last (final) channel modeled. Labeled common blocks in MSED3 have names of the form VAR*, where * is a positive integer. The labeled common blocks in program MULTSED3 are VAR1, VAR2, VAR6 and VAR7.

Subroutine MSED2

This subroutine is used to reorder and reformat the output created by MSED1. It essentially changes a 1 x n vertical file into a 4 x (n/4) horizontal and vertical file. It uses file 7 to create files 3 and 4, and file 8 to create files 13 and 14. File 7 was originally the output file for the plane units and file 8 was the output unit for the watershed units.

Subroutine DATA1

In this subroutine, the channel indexes and characteristics are read. The internal file number is designated as 9. The subroutine also reads information from files 3, 4, 13, and 14 that were created by subroutine MSED2. Files 3 and 14 are left open to be read later in the subroutine. This subroutine also recognizes and reads data that describe small reservoirs (stock ponds) in the channel system. In these cases, reservoir data instead of channel data are read. Labeled common blocks are VAR 1 through 10, and 15 through 18. Some conversions of the reservoir data are performed, and the representative grain sizes are calculated.

Subroutine TEMP

The function of this subroutine is identical to the one found in submodel MSED1. However, in this subroutine, the hydraulic conductivity of the stream bottom is modified. The labeled common blocks are VAR 1, 2, and 5.

Subroutine INITL

This subroutine is used to initialize variables in the submodel. Several values are set to zero, some values have units changed, and the fall velocity for sediment particles is calculated for later use in subroutine TRANSP. Labeled common blocks are VAR 1 through 9, and 17.

Subroutine ROUTE

This subroutine is the primary computational center for the submodel. From here, subroutines DATA2, RES, UPLAT, RESIS, CHINL, WROUT, PERTG, TRANSP, SROUT, CEASE, and OUT are called. As information is passed back to ROUTE from the called subroutines, it is either passed directly into the next subroutine called or it is modified. Subroutine ROUTE does summations and conversions on the output before calling subroutine OUT. Labeled common blocks are VAR 1, 2, 7, 8, 9, and 17.

Subroutine DATA2

This subroutine is used to read information from files 3 and 14 that were created by subroutine MSED2. These files may be read at each time step, if needed. Based on the flow volume weighting, sediment yields from the plane and watershed units are converted to volume concentrations at each time step. Labeled common blocks are VAR 1 and 15.

Subroutine RES

This subroutine is called by ROUTE if the segment is identified as a reservoir. This subroutine uses simple inflow, outflow, and change in storage to determine the volume of water that passes through the reservoir. It also uses a trapping coefficient (supplied in the input data) to determine the amount of sediment deposited in the reservoir. Sediment that is not completely trapped is allowed to go downstream with the water into the next channel. Using the model to analyze the effects of reservoirs on a watershed is cautioned against because of the simplistic nature of this subroutine and some continuity errors that were noticed when reservoirs were used in other model applications. Labeled common blocks are VAR 1, 2, 7, 8, 9, and 17. This subroutine calls subroutine UPRES.

Subroutine UPRES

This subroutine is used to identify those upstream channels and watershed units that directly contribute to a reservoir. Once identified, all water and sediment inflows are summed to arrive at a total inflow for the time period. Labeled common blocks are VAR 1, 3, 7, 8, 15, and 17.

Subroutine UPLAT

This subroutine is used for channels and is similar to UPRES except it also identifies lateral inflows to the channel. Once identified, the water and sediment loadings during the time period are computed. Labeled common blocks are VAR 1, 3, 7, 8, 9, 10, and 15.

Subroutine CHINL

This subroutine is used to simulate infiltration in the channel. It has been modified from the original MULTSED version that infiltrated too much water because of summation problems in the algorithms. Infiltration is calculated using a modified Green-Ampt

formulation that incorporates the previous flow depth in the channel as part of the head term. If infiltration is not desired, a hydraulic conductivity of 0.0 should be used in the data set. Labeled common blocks are VAR 1, 2, 9, and 10.

Subroutine RESIST

This subroutine is the same as that in submodel MSED1.

Subroutine WROUT

This subroutine is the water routing component of the submodel. It uses an unconditionally stable finite difference routing technique to move water from section to section in the channel. The technique uses linear and nonlinear schemes to iterate to a solution that satisfies a convergence criteria related to the flow area. Labeled common blocks are VAR 1, 8, 9, and 10.

Subroutine PERTG

This subroutine is used to determine how much sediment is available on the stream bed for erosion during each time step. If sediment is available, then size fractions are recalculated to reflect the composition of the materials that are left. As the finer materials are washed away, the coarser particles armor the bed of the stream and, unless flow increases, erosion and sediment transport decrease. Labeled common blocks are VAR 1, 2, 7, 8, and 9.

Subroutine TRANSP

This subroutine is similar to TRANSP in submodel MSED1, except that only the transport capacity is determined and not the supply and resultant sediment yield. Labeled common blocks are VAR 1 through 5, 7 through 10, and 18. This subroutine calls subroutine POWER.

Subroutine POWER

This subroutine performs the same function it performs in submodel MSED1.

Subroutine SROUT

This is a very complex subroutine that is used to route sediment through each of the five equal-length subdivisions. The channel is subdivided to aid routing. At each channel reach, the sediment transport rate as determined by TRANSP is compared with the available sediment from the upstream reach or inflow, the lateral inflow, and the material left on the streambed from the previous time period. Sediments that can be transported are transported to the next reach and those that cannot be transported are deposited on the stream bottom to await the next discharge. Eventually the finer sizes are removed from the channel and the larger sizes remain. Labeled common blocks are VAR 1, 2, 4, 5, 7 through 10, and 18.

Subroutine CEASE

This subroutine is used when lateral inflow has ended so that sediment is not immediately stopped. Labeled common blocks are VAR 1, 4, and 7 through 10.

Subroutine OUT

This subroutine is used to write the model output from all the channels to file 11, MSED11.OUT, and to write output from the last (final) channel to the CRT and file 6, SCREEN3.OUT. Labeled common blocks are VAR 1, 2, 6, and 17.

3 MODEL MODIFICATIONS AND LIMITATIONS

Modifications

The MULTSED model has undergone several modifications since the original version was developed. A significant change was to adapt the model to run on MS-DOS compatible computers. The model is no longer restricted to mainframe or minicomputer applications. The model has been streamlined further by: (1) removing Chezy's C from MSED1 and MSED3, (2) assigning constant values to DPOW and TAOCK in MSED1, (3) assigning constant values to AGB, BEX, and DELTS in MSED3, and (4) removing the connection unit inputs from MSED3. Data files have been combined so there is only one user-supplied file for each MSED submodel rather than the two separate files used in the original submodels. The formats and contents of the new data files are listed in Appendix B. The TRANSP subroutine in MSED1 was rewritten to combine overland and channel flow sediment yield calculations in one subroutine instead of the two, almost identical, subroutines in the original version. On the plane, infiltration was turned off once rainfall excess ended, and in the channel, infiltration can be turned off by entering a zero for hydraulic conductivity. Submodel MSED2 was rewritten as a subroutine for submodel MSED3. Data files were combined so that indices proceed characteristics in a single file. Various logic and computation errors discovered by other researchers who applied the model have been incorporated as appropriate.

Limitations

The model still has some limitations and shortcomings. First, the user is restricted to 75 response units for MSED1 with 200 time steps. The restriction for MSED3 is a total of 35 channels and reservoirs and 200 time steps. Second, experience indicates that watershed units should not exceed 2 sq mi and channel lengths should not exceed 1 mi. Similarly, channel lengths in MSED3 should not exceed 1 mi. Although the model will still operate if a single channel is longer than 1 mi or a single watershed is larger than 2 sq mi, the resultant hydrographs and sediment yields do not make any sense in terms of timing. Larger areas and lengths should be avoided. Third, the time increment in minutes and the final time (duration) of the hydrograph seem to affect the peak flow rates. There is no logical explanation why this has occurred in some applications, but experience has indicated that the shorter the time step (down to 1 minute, minimum), the more reliable the answer. Fourth, the time step of the rainfall hyetograph can affect the results. If a long hyetograph time step is used, the resultant infiltration and subsequent excess rainfall rates may not be estimated very well. Therefore, short time steps are recommended. Fifth, the sediment transport equations used in the model are not appropriate when shear stress caused by steep slopes and/or high flow rates greatly exceeds the stress needed to move the particles. Sixth, routing in the channels can be greatly affected by the choice of channel cross-sectional parameters. Trying to force the channel to act as a rectangle with no relationship between flow area and wetted perimeter causes errors in the outflow rates so that they exceed the rainfall rates. Seventh, the model will stop without warning if a long final time is selected for the hydrograph duration.

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APPENDIX A:

SOURCE CODE LISTINGS

```
      PROGRAM MULTSED1
C
C     THIS PROGRAM WAS ORIGINALLY DEVELOPED AT COLORADO STATE
C     UNIVERSITY IN THE LATE 1970'S.  IT HAS BEEN MODIFIED BY
C     RESEARCHERS AT NEW MEXICO STATE UNIVERSITY AND THE
C     UNIVERSITY OF ILLINOIS.  TIM WARD AT NEW MEXICO STATE
C     UNIVERSITY HAS CONVERTED IT TO RUN ON THE IBM PC USING
C     MS-FORTRAN.
C           LAST UPDATE: JUNE 1987 BY TJW
C
      COMMON/SED/ DCOEFF,DPOW,DOF,CHDOF,TAOCK,NSED,PSI(10),DMBI(10)
      DIMENSION QDUM(200),ITYPE(75),TITLE(20),ISEG(75),YIELD(10,3),
     +          TYIELD(3),IPRINT(75)
      CHARACTER*20 FNAME1
C
C      ---  INITIALIZE VARIABLES.
C     EXTERNAL INDEX
      TUP = 0.0
      TIN = 0.0
      TOUT = 0.0
      TRVOL=0.0
      TVINTR = 0.0
      TAREA = 0.0
      DO 101 I=1,200
        QDUM(I)=0.0
  101 CONTINUE
C     ASK FOR THE NAMES OF THE INPUT FILES
      WRITE(*,9000)
 9000 FORMAT(30(/),30X,'WELCOME TO MULTSED1',/,
     *23X,'PC VERSION V87.06 BY TIM J. WARD',10(/))
      WRITE(*,9001)
 9001 FORMAT(10X,'WHAT IS THE NAME OF THE MSED1 INPUT FILE?'
     *,1X,\)
      READ(*,9010) FNAME1
 9010 FORMAT(A)
      WRITE(*,9012) FNAME1
 9012 FORMAT(//,10X,'OPENING FILE ',A20,' AS THE INPUT FILE.',/,
     1    10X,'OPENING SCREEN1.OUT AS THE SCREEN OUTPUT FILE.',/,
     2    10X,'OPENING MSED7.DAT AS AN OUTPUT FILE FOR MSED3.',/,
     3    10X,'OPENING MSED8.DAT AS AN OUTPUT FILE FOR MSED3.',/)
C
      OPEN(1,FILE=FNAME1,STATUS='OLD')
      OPEN(6,FILE='SCREEN1.OUT',STATUS='NEW')
      OPEN(7,FILE='MSED7.DAT',STATUS='NEW')
      OPEN(8,FILE='MSED8.DAT',STATUS='NEW')
C
C     START READING THE DATA
      READ(1,4000)(TITLE(I),I=1,20)
 4000 FORMAT(20A4)
      WRITE (6,4001)(TITLE(I),I=1,20)
 4001 FORMAT(1H ,' TITLE: ',20A4)
      WRITE (*,4002)(TITLE(I),I=1,15)
 4002 FORMAT(30(/),35X,'MSED1 IS NOW RUNNING.',/,
     *10X,'THE WATERSHED TITLE IS: ',/,15X,15A4,15(/))
```

```
C       ---  READ IN THE TIME INCREMENT AND FINAL TIME FOR THE
C       ---  HYDROGRAPH.
      READ(1,4003)DTIM,FTIM
 4003 FORMAT(2F10.0)
C
C       ---  READ NUMBER OF  PLANES (NPL),
C       ---  NUMBER OF SMALL WATERSHEDS (NWS)
      READ(1,1000)NPL,NWS
 1000 FORMAT(3I10)
C       ---  READ IN TYPE ARRAY TO IDENTIFY THE TYPE OF UNITS.
      NUMP=NPL+NWS
      DO 104 I=1,NUMP
        READ(1,1000)ISEC(I),ITYPE(I),IPRINT(I)
  104 CONTINUE
C       --- CONVERT TIMES TO SECONDS
      DTIM=DTIM*60.
      FTIM=FTIM*60.
C       ---  CALCULATE NUMBER OF INCREMENTS IN HYDROGRAPH.
      NUM=IFIX(FTIM/DTIM)+1
C     WRITE THE RESULTS TO THE SCRATCH FILES FOR USE IN MSED3
      WRITE(8,6000)NWS,NUM
      WRITE(7,6000)NPL,NUM
 6000 FORMAT(6I10)
C
      IF (NUMP.EQ.1.AND.NPL.EQ.1) THEN
C       ---  IF NO CHANNELS NEED TO BE ROUTED THEN USE ONLY
C       ---  THE SMALL WATERSHED MODEL (ANAWAT).
      CALL ANAWAT(1,DTIM,FTIM,QDUM,TVINTR,TAREA,TRVOL,YIELD,TYIELD,
     +            QT,NUM)
C       ---  CONVERT TOTALS FROM CFS TO AC-FT UNITS.
      TVINTR=TVINTR/43560.
      TAREA=TAREA/43560.
      TRVOL=TRVOL/43560.
      ID = 0
      CALL OUT(ISEG(K1),YIELD(1,3),QDUM,NUM,QT,TAREA,TVINTR,NSED,DTIM,
     +         DMBI,TYIELD(3),TRVOL,ID)
      STOP 1
      ENDIF
C
C     START THE LOOP FOR THE PLANES AND THE WATERSHEDS
C
        DO 109 K1=1,NUMP
          WRITE(*,9002) K1
9002      FORMAT(//,20X,'MSED1 IS COMPUTING FOR RESPONSE UNIT ',I3,/)
          DO 110 IK2=1,NUM
            QDUM(IK2)=0.0
  110     CONTINUE
          T1=0.
          T2=0.
          T3=0.
C
          K2 = ITYPE(ISEG(K1))
          ID = K2
          GOTO (11,12),K2
```

```
C      ---  THIS IS THE ONE PLANE CASE.
   11 CALL ANAWAT(ISEG(K1),DTIM,FTIM,QDUM,T1,T2,T3,
     +            YIELD,TYIELD,QT,NUM)
        WRITE(7,6000) ISEG(K1),NSED
        WRITE(7,6005)(YIELD(K3,1),K3=1,NSED)
        WRITE(7,6005)QT
        WRITE(7,6005)(QDUM(K3),K3=2,NUM)
        IF(IPRINT(ISEG(K1)).LT.0) GO TO 109
        T1=T1/43560.
        T2=T2/43560.
        T3=T3/43560.
        CALL OUT(ISEG(K1),YIELD,QDUM,NUM,QT,T2,T1,NSED,
     +             DTIM,DMBI,TYIELD,T3,ID)
        GO TO 109
C      ---  THIS IS THE SUBWATERSHED CASE (2 PLANES & 1 CHANNEL)
   12 CALL ANAWAT(ISEG(K1),DTIM,FTIM,QDUM,T1,T2,T3,
     +            YIELD,TYIELD,QT,NUM)
        WRITE(8,6000) ISEG(K1),NSED
        WRITE(8,6005)(YIELD(K3,3),K3=1,NSED)
        WRITE(8,6005) QT
        WRITE(8,6005)(QDUM(K3),K3=2,NUM)
 6005 FORMAT(4G15.6)
        IF(IPRINT(K1).LT.0) GO TO 109
        T1=T1/43560.
        T2=T2/43560.
        T3=T3/43560.
        CALL OUT(ISEG(K1),YIELD(1,3),QDUM,NUM,QT,T2,T1,NSED,DTIM,DMBI,
     +             TYIELD(3),T3,ID)
  109 CONTINUE
       REWIND 8
       REWIND 7
       CLOSE(8)
       CLOSE(7)
      STOP '                          MSED1  IS FINISHED'
      END
C
```

```
C      ******************************************************************
C
      SUBROUTINE ANAWAT(IFILE,DTIM,FTIM,QOUT,TVINTR,TAREA,TRVOL,
     +                  YIELD,TYIELD,QT,NUM)
C
C     THIS IS THE PRIMARY CALLING SUBROUTINE THAT CONTROLS
C     ALL OF THE OTHER SUBROUTINES.
C
C      ---  PARAMETER DEFINITIONS
C             IFILE  = SUBUNIT NUMBER.
C             DTIM   = TIME INCREMENT FOR HYDROGRAPH.
C             FTIM   = FINAL TIME OF HYDROGRAPH.
C             QOUT   = ARRAY OF THE RESULTING DISCHARGES.
C             TVINTR = TOTAL VOLUME OF INTERCEPTION IN FT**3.
C             TAREA  = TOTAL AREA IN FT**2.
C             TRVOL  = TOTAL VOLUME OF RAINFALL IN FT**3.
C
      COMMON/COVER/ GRNCOV(2),CANCOV(2),VG(2),VC(2),FIMP(2),SLOOSE(2)
      COMMON/DEPTH/ Y(200)
      COMMON/SED/ DCOEFF,DPOW,DOF,CHDOF,TAOCK,NSED,PSI(10),DMBI(10)
      DIMENSION PLNGTH(3),SLOPE(3),RAINOD(200),RAINT(200),
     +          EXCES(200),EXCEST(200),RAIN(200),OUTIME(200),RT(200),
     +          QLT(200),QLTIME(200),QL(200,2),QOUT(200),TYIELD(3),
     +          YIELD(10,3)
C
C      --- INITIALIZE VARIABLES.
      CHECK=0.0
      TRVOL=0.0
      TAREA = 0.0
      TVINTR = 0.0
      ICHECK = 0
      ERR = 0.0
      TYIELD(1)=0.0
      TYIELD(2)=0.0
      TYIELD(3)=0.0
      DO 101 I=1,200
        QL(I,1)=0.0
        QL(I,2)=0.0
        QOUT(I) = 0.0
        QLT(I) = 0.0
        QLTIME(I) = 0.0
        Y(I)=0.0
  101 CONTINUE
      DO 313 I=1,10
        YIELD(I,1)=0.0
        YIELD(I,2)=0.0
        YIELD(I,3)=0.0
  313 CONTINUE
C      ---  INPUT ALL DATA FOR ANAWAT FROM THE FIRST FILE.
      CALL INPUT(IPLANE,RAINOD,RAINT,NRAIN,PLNGTH,SLOPE,
     +           T,ADW,XN,A1,B1)
      NR=NRAIN
C      ---  CALCULATE VISCOSITY AND CORRECT HYDRAULIC CONDUCTIVITY
C      ---  FOR TEMPERATURE.
```

```
      CALL TEMP(T,VISCO, IPLANE)
C       ---  CALCULATE TOTAL INCHES OF RAINFALL.
      TRINCH=RAINOD(1)*RAINT(1)
      DO 100 I=2,NRAIN
        TRINCH=RAINOD(I)*(RAINT(I)-RAINT(I-1))+TRINCH
  100 CONTINUE
C       ---  THE FOLLOWING LOOP CALCULATES THE EXCESS OF EACH
C       ---  PLANE AND ROUTES THE EXCESS ON EACH PLANE.
      DO 102 I=1,IPLANE
       QT = 0.0
C      --- CALCULATE AREA OF PLANE (AREA).
        AREA=PLNGTH(I)*PLNGTH(3)
        TAREA=TAREA+AREA
C       ---  CALCULATE RAINFALL VOLUME.
        TRVOL=TRVOL+AREA*TRINCH/12.
C       ---  INITIALIZE RAIN ARRAY EQUAL TO RAINOD ARRAY.
        NRAIN=NR
        DO 103 J=1,NRAIN
          RAIN(J)=RAINOD(J)
          RT(J)=RAINT(J)
  103   CONTINUE
        DO 113 J=1,200
          EXCEST(J)=0.0
          EXCES(J)=0.0
  113 CONTINUE
C       ---  CALCULATE THE INTERCEPTION
        CALL INTRCP(ERR,RAIN,RT,NRAIN,VINTR,I)
        TVINTR=TVINTR+VINTR*AREA/12.
        IF(ERR.EQ.0.0) GO TO 10
        ERR=0.0
        GO TO 50
C      --- CALCULATE THE INFILTRATION.
   10 CALL CUTOFF(ERR,EXCES,EXCEST,NEX,RAIN,RT,NRAIN,
     +  I,FTIM)
        IF(ERR.EQ.0.0.OR.FIMP(I).GT.0.0) GO TO 20
        ERR=0.0
C       ---  FOR THE CASE WHEN THE TOTAL RAINFALL IS COMPLETELY
C       ---  INTERCEPTED AND/OR INFILTRATED.
   50 IF(IPLANE.EQ.1) RETURN
        ICHECK=ICHECK+1
        IF(ICHECK.EQ.2) RETURN
        DO 104 IT=1,200
          QL(IT,I)=0.0
  104 CONTINUE
        GO TO 102
C       ---  CONVERT UNITS OF EXCESS RAINFALL IN/MIN TO FT/SEC
C       ---  AND UNITS OF TIME FROM MIN. TO SEC.
   20 NNEX=NEX-1
        DO 105 J=2,NNEX
      EXCES(J)=(EXCES(J)*(1.-FIMP(I))+RAIN(J-1)*FIMP(I))/720.
         EXCEST(J)=EXCEST(J)*60.
  105 CONTINUE
      EXCES(NEX)=EXCES(NEX)*(1.-FIMP(I))/720.
      EXCEST(NEX)=EXCEST(NEX)*60.
```

```
C       ---  DEFINE B. B IS USED IN THE EQUATION Q=A*Y**B.
C       ---  B=3.0 FOR THE CASE OF OVERLAND FLOW.
         B=3.0
C       ---  DEFINE A. A IS USED IN THE EQUATION Q=A*Y**B.
C       ---  FOR OVERLAND FLOW A IS A FUNCTION OF THE GROUND
C       ---  COVER, SLOPE, AND VISCOSITY OF WATER.
         R=100.+(ADW-100.)*(GRNCOV(I)/100.)**2.
         G=32.174
         A=8.*SLOPE(I)*G/(R*VISCO)
C       ---  CALL THE FORWARD ROUTING PROCEDURE.
         CALL FORWRD(A,B,PLNGTH(I),EXCES,EXCEST,NEX,OUTIME,TSTOP,FTIM
     +,            CHECK)
         IF(IPLANE.EQ.2) GO TO 60
         CALL BACK(A,B,PLNGTH(I),DTIM,TSTOP,OUTIME,EXCEST,EXCES,
     +   QOUT,NEX,CHECK)
           ID = 0
         CALL TRANSP(ID,I,SLOPE,PLNGTH,NR,RAINT,RAINOD,R,QOUT,QL(1,I),
     +                      DTIM,FTIM,VISCO,A,B,YIELD,TYIELD)
       QT=0.0
       DO 201 JJ=2,NUM
          QT=QT+(QOUT(JJ)+QOUT(JJ-1))/2.
  201  CONTINUE
       QT=QT*PLNGTH(3)*DTIM/43560.
       DO 202 JJ=1,NSED
           YIELD(JJ,1)=YIELD(JJ,1)/PLNGTH(3)
  202  CONTINUE
         RETURN
   60  CALL BACK(A,B,PLNGTH(I),DTIM,TSTOP,OUTIME,EXCEST,
     +   EXCES,QL(1,I),NEX,CHECK)
         ID = 1
       CALL TRANSP(ID,I,SLOPE,PLNGTH,NR,RAINT,RAINOD,R,QIUT,QL(1,I),
     +                      DTIM,FTIM,VISCO,A,B,YIELD,TYIELD)
  102  CONTINUE
C       ---  TO ROUTE THE CHANNEL CALL QLAT TO SUM THE LATERAL
C       ---  INFLOWS.
        NQ=IFIX(FTIM/DTIM)
       CALL QLAT(QL,QLT,QLTIME,DTIM,NQ)
       IF(A1.NE.0.0) GO TO 215
C       ---  DEFINE B.  B IS USED IN THE EQUATION Q=A*Y**B.
C       ---  FOR A CHANNEL WITH A TRIANGULAR CROSS SECTION
C       ---  B=1.25.
       B1=0.5
C       ---  DEFINE A.  A IS USED IN THE EQUATION Q=A*Y**B.
C       ---  FOR A CHANNEL A IS A FUNCTION OF THE CHANNEL
C       ---  GEOMETRY (A1), CHANNEL SLOPE (SLOPE(3)), AND THE
C       ---  DARCEY-WEISBACH RESISTANCE FACTOR (RESIST).
       A1 = ((2./((1./SLOPE(1))+(1./SLOPE(2))))**0.5)*
     +      ((1.+(1./SLOPE(1)**2))**0.5
     +       +(1.+(1./SLOPE(2)**2))**0.5)
  215  CONTINUE
       CALL RESIST(XN,A1,B1,A,B,SLOPE(3))
C       ---  ROUTE THE CHANNEL.
        CHECK=1.
       CALL FORWRD(A,B,PLNGTH(3),QLT,QLTIME,NQ,OUTIME,TSTOP,FTIM
```

```
     +,              CHECK)
      CALL BACK(A,B,PLNGTH(3),DTIM,TSTOP,OUTIME,QLTIME,QLT,
     +          QOUT,NQ,CHECK)
        ID = 2
      CALL TRANSP(ID,I,SLOPE,PLNGTH,NR,RAINT,RAINOD,R,QOUT,QL(1,I),
     +                  DTIM,FTIM,VISCO,A1,B1,YIELD,TYIELD)
      QT=0.0
      DO 205 JJ=2,NUM
      QT =QT+(QOUT(JJ-1)+QOUT(JJ))/2.
  205 CONTINUE
      QT=QT*DTIM/43560.
  109 CONTINUE
      RETURN
      END
C
```

```
C      ************************************************************************
C
       SUBROUTINE INPUT(IPLANE,RAINOD,RAINT,NRAIN,
     +                  PLNGTH,SLOPE,T,ADW,XN,A1,B1)
C
C     ---  THIS SUBROUTINE READS WATERSHED DATA FOR THE
C     ---  SUBROUTINE ANAWAT.  DATA IS READ FROM THE FILE
C     ---  WITH UNIT NUMBER = 1.
C     ---  PARAMETER DEFINITIONS.
C            IPLANE = INDICATOR OF WHETHER 1-PLANE OR 2-PLANES
C                     AND 1 CHANNEL IS IN THIS PARTICULAR WATER-
C                     SHED.
C            RAINOD=ARRAY OF RAINFALL INTENSITIES FOR THE STORM.
C            RAINT  = ARRAY OF FINAL TIMES CORRESPONDINC TO THE
C                     RAINFALL INTENSITIES.
C            NRAIN  = NUMBER OF RAINFALL INCREMENTS (INTENSITIES).
C            PLNGTH = ARRAY OF PLANE & CHANNEL LENGTHS.
C            SLOPE  = ARRAY OF PLANE & CHANNEL SLOPES.
C            T      = TEMPERATURE OF WATER.
C
      COMMON/COVER/ GRNCOV(2),CANCOV(2),VG(2),VC(2),FIMP(2),SLOOSE(2)
      COMMON/SOIL/ WET K(2),POROS(2),SAVE(2),SW(2),SI(2),
     +             PLASI(3),COHM(3)
      COMMON/SED/ DCOEFF,DPOW,DOF,CHDOF,TAOCK,NSED,PSI(10),DMBI(10)
      COMMON/VAR1/ TITL
      DIMENSION TITL(3)
      DIMENSION RAINOD(200),RAINT(200),PLNGTH(3),SLOPE(3),
     -          P(11),D(11),DPRES(3),PIMP(2)
C
C     ---  READ NUMBER OF PLANES.
      READ(1,1000)(TITL(I),I=1,3),IPLANE
 1000 FORMAT(//3A4,I10)
C     ---  FOR EACH PLANE READ HYDRAULIC CONDUCTIVITY,
C     ---  SOIL POROSITY, INITIAL SOIL SATURATION,
C     ---  FINAL SOIL SATURATION AND AVERAGE SUCTION
      DO 100 I=1,2
        READ(1,2000)WET K(I),POROS(I),SI(I),SW(I),SAVE(I),PLASI(I),
     +               COHM(I)
 2000 FORMAT(7F10.0)
C     ---  CHANGE HYDRAULIC CONDUCTIVITY TO UNITS OF IN/MIN.
        WET K(I)= WET K(I)/60.
  100 CONTINUE
C     ---  READ IN CANOPY AND GROUND COVER DATA FOR EACH PLANE.
C     ---  PIMP IS THE PERCENT OF IMPERVIOUS COVER AND
C     ---  SLOOSE IS THE AMOUNT OF LOOSE SOIL (POUNDS) AVAILABLE IN
C     ---  ADDITION TO THAT WHICH WILL BE SPLASH OR FLOW DETACHED.
      READ(1,3000)(CANCOV(I),VC(I),GRNCOV(I),VG(I),
     +             PIMP(I),SLOOSE(I),I=1,2)
      FIMP(1)=PIMP(1)/100.
      FIMP(2)=PIMP(2)/100.
 3000 FORMAT(6F10.0)
C     ---  READ IN SLOPE AND LENGTH OF EACH PLANE.
C     ---  DEPRES IS THE FRACTION OF THE PLANE
C     ---  IN DEPRESSION STORAGE.
```

```
      READ(1,4000)(SLOPE(I),PLNGTH(I),DPRES(I),I=1,2)
      READ(1,4000) SLOPE(3),PLNGTH(3)
 4000 FORMAT(3F10.0)
C      ---  DECREASE THE LENGTH OF THE PLANE BY THE FRACTION
C      ---  OF THE DEPRESSION STORAGE.
      PLNGTH(1)=PLNGTH(1)*(1.-DPRES(1))
      PLNGTH(2)=PLNGTH(2)*(1.-DPRES(2))
C
C      --- READ IN CHANNEL AND RAIN/WATER INDICES.
C      --- IN THE ORIGINAL VERSION, CHEZY'S C WAS READ HERE.
      READ(1,5000)NRAIN,T,XN,A1,B1,ADW,COHM(3)
 5000 FORMAT(I10,6F10.0)
C      ---  READ IN STORM RAINFALL DATA.
      DO 200 I=1,NRAIN
        READ(1,6000) RAINOD(I),RAINT(I)
 6000 FORMAT(2F10.0)
C      ---  CONVERT INTENSITY FROM IN/HR TO IN/MIN.
        RAINOD(I)=RAINOD(I)/60.
  200 CONTINUE
C      ---  READ IN SEDIMENT TRANSPORT/EROSION CHARACTERISTICS.
C      ---  DPOW AND TAOCK ARE NOW SET AS CONSTANTS
      READ(1,1010)DCOEFF,DOF,CHDOF,PLASI(3),NSED
 1010 FORMAT(4F10.0,I10)
               DPOW = 2.0
               TAOCK = 0.047
C      ---  READ IN THE SEDIMENT SIZE DISTRIBUTION
C      ---  AND CALCULATE THE GEOMETRIC MEAN SIZE
C      ---  AND FRACTION FOR EACH INCREMENT.
      DO 210 I=1,NSED
        READ(1,6000)D(I),P(I)
        IF (I.GT.1) THEN
           IB = I - 1
           PSI(IB)=ABS(P(I)-P(IB))
           DMBI(IB)=(D(I)*D(IB))**.5/304.8
        ENDIF
  210 CONTINUE
      NSED=NSED-1
      RETURN
      END
C
```

```
C      ************************************************************
C
       SUBROUTINE TEMP(T,VISCO,IPLANE)
C
C       ---  THIS SUBROUTINE CORRECTS THE VISCOSITY AND
C       ---  HYDRAULIC CONDUCTIVITY FOR TEMPERATURE VARIATIONS
C       ---  FROM THE ASSUMED TEMPERATURE OF 68 DEGREES (F).
C       ---  PARAMETER DEFINTIONS.
C              T      = TEMPERATURE IN DEGREES F.
C              VISCO  = KINEMATIC VISCOSITY (FT**2/SEC)
C              IPLANE = NUMBER OF PLANES.
C
       COMMON/SOIL/ WET K(2),POROS(2),SAVE(2),SW(2),SI(2),
     +              PLASI(3),COHM(3)
       DIMENSION TE(10),V(10)
       DATA TE/32.,40.,50.,60.,68.,80.,90.,100.,120.,140./,
     +V/1.93,1.66,1.41,1.22,1.09,0.930,0.826,0.739,0.609,0.514/
C
C       ---  CALCULATE NEW VISCOSITY BY INTERPOLATION.
       DO 100 I=1,10
         IF(TE(I).LT.T) GO TO 100
         FAC1=(T-TE(I-1))/(TE(I)-TE(I-1))
         VISCO=V(I-1)+FAC1*(V(I)-V(I-1))
         GO TO 10
  100 CONTINUE
C       ---  ADJUST THE HYDRAULIC CONDUCTIVITY.
   10 FAC2=VISCO/1.09
       DO 101 J=1,IPLANE
         WET K(J)=WET K(J)/FAC2
  101 CONTINUE
       VISCO=VISCO*.00001
       RETURN
       END
C
```

```
C     ****************************************************************
C
      SUBROUTINE INTRCP(ERR,RAIN,RAINT,NRAIN,VINTR,IPL)
C
C      ---  THIS SUBROUTINE DETERMINES THE VOLUME OF
C      ---  INTERCEPTED RAINFALL. INTERCEPTION DEPENDS
C      ---  ON THE PERCENTAGE OF THE GROUND THAT IS
C      ---  COVERED BY (CANCOV) AND GROUND (GRNCOV), AND
C      ---  THEIR RESPECTIVE WATER HOLDING CAPACITIES(VC,VG).
C      ---  TOTAL INTERCEPTED VOLUME = VINTR.
C      ---  PARAMETER DEFINITIONS.
C             ERR    = ERROR INDEX.
C             RAIN   = ARRAY OF RAINFALL INTENSITIES.
C             RAINT  = ARRAY OF FINAL TIMES FOR EACH RAINFALL
C                      INTENSITY.
C             NRAIN  = NUMBER OF RAINFALL INTENSITIES.
C             VINTR  = TOTAL AMOUNT OF RAINFALL INTERCEPTED IN INCHES.
C             IPL    = INDICATOR OF WHICH PLANE THE EXCESS IS
C                      BEING CALCULATED.
C
      COMMON/COVER/ GRNCOV(2),CANCOV(2),VG(2),VC(2),FIMP(2),SLOOSE(2)
      DIMENSION R OLD(200),RAIN(200),RAINT(200),RTOLD(200)
C
C      ---  THE R OLD IS AN ARRAY WHICH TEMPORARILY STORES THE
C      ---  STORM INTENSITIES. OPERATIONS ARE DONE ON THE R OLD
C      ---  ARRAY TO OBTAIN AN ARRAY WHICH EQUALS THE TOTAL
C      ---  RAINFALL MINUS THE RAINFALL THAT IS LOST BY
C      ---  INTERCEPTION.
C      ---  INITIALIZE R OLD ARRAY EQUAL TO RAIN ARRAY.
      DO 100 I=1,NRAIN
        R OLD(I)= RAIN(I)
        RTOLD(I)=RAINT(I)
  100 CONTINUE
C      ---  CALCULATE TOTAL INTERCEPTED VOLUME OF RAINFALL.
      VGC=GRNCOV(IPL)*VG(IPL)/100.
      VCC=CANCOV(IPL)*VC(IPL)/100.
      VINTR =VGC+VCC
      VRAIN = 0.
C      ---  THE RAINFALL LOST TO INTERCEPTION IS SUBTRACTED
C      ---  FROM THE TOTAL RAINFALL.
      DO 101 I=1,NRAIN
        IF(I.EQ.1) GO TO 10
        VRAIN =VRAIN+R OLD(I)*(RAINT(I)-RAINT(I-1))
        GO TO 11
   10 VRAIN = VRAIN+R OLD(1)*RAINT(1)
   11 IF(VRAIN.GT.VINTR) GO TO 12
        RAIN(I) = 0.
  101 CONTINUE
      GO TO 13
   12 DRV =VRAIN-VINTR
      DT=DRV/RAIN(I)
      IF(I.EQ.1) GO TO 14
      RAINT(I-1)=RAINT(I)-DT
      RETURN
```

```
   14 RAIN(1)=0.0
      RAINT(1)=RAINT(1)-DT
      GO TO 15
C       ---  PRINT WARNING IF TOTAL RAINFALL IS LESS THAN
C       ---  TOTAL INTERCEPTED VOLUME OF RAINFALL.
   13 ERR=1.0
      WRITE(*,1000)VRAIN
      WRITE(6,1000)VRAIN
 1000 FORMAT(//' THE ENTIRE VOLUME OF RAINFALL ',F10.3,
     +' INCHES,'/' HAS BEEN ABSORBED BY INTERCEPTION.'/)
      GO TO 16
C       ---  RESET RAIN ARRAY EQUAL TO R OLD ARRAY.
   15 CONTINUE
      NRAIN=NRAIN+1
       DO 102 I=2,NRAIN
        RAIN(I)=R OLD(I-1)
        RAINT(I)=RTOLD(I-1)
  102 CONTINUE
   16 RETURN
      END
C
```

```
C     ***************************************************************
C
      SUBROUTINE CUTOFF(ERR,EXCES,EXCEST,NEX,RAIN,RAINT,NRAIN,
     +                  IPL,FTIM)
C
C      ---  THIS SUBROUTINE CALCULATES THE EXCESS RAINFALL.
C      ---  INFILTRATED RAINFALL BASED ON THE GREEN-AMPT EQUATION.
C      ---  THIS IS NOT A CONTINUED INFILTRATION MODEL (INFILTRATION
C      ---  DOES NOT CONTINUE AFTER THE END OF THE RAINFALL).
C
C      ---  PARAMETER DEFINITIONS.
C             ERR    = ERROR INDEX.
C             EXCES  = ARRAY CONTIANING EXCESS RAINFALL
C                      INTENSITY VALUES.
C             EXCEST = ARRAY CONTIANING THE FINAL TIMES FOR
C                      EACH EXCESS INTERVAL.
C             NEX    = NUMBER OF EXCESS INTERVALS.
C             RAIN   = ARRAY OF RAINFALL INTENSITIES.
C             RAINT  = ARRAY OF FINAL TIMES FOR EACH RAINFALL
C                      INTENSITY.
C             NRAIN  = NUMBER OF RAINFALL INTERVALS.
C             IPL    = INDICATOR OF WHICH PLANE THE EXCESS
C                      IS BEING CALCULATED.
C             FTIM   = FINAL TIME OF HYDROGRAPH.
C
C
      COMMON/SOIL/ WET K(2),POROS(2),SAVE(2),SW(2),SI(2),
     +             PLASI(3),COHM(3)
      COMMON/COVER/ GRNCOV(2),CANCOV(2),VG(2),VC(2),FIMP(2),SLOOSE(2)
      DIMENSION RAIN(200),RAINT(200),EXCES(200),EXCEST(200)
C
C      ---  INITIALIZE VARIABLES.
      ITP=0
      FO1 = 0.
      FO2 = 0.
      T = 0.
      FTIMM=FTIM/60.
      EXCES(1) = 0.
      EXCEST(1) = 0.
      GAMMA=SAVE(IPL)*POROS(IPL)*(SW(IPL)-SI(IPL))
C      ---  CALCULATE NUMBER OF EXCESS INCREMENTS.
      NEX=NRAIN+1
C      ---  THE FOLLOWING LOOP ITERATES EXCESS INCREMENTS.
      DO 105 I=1,NRAIN
C      ---  CALCULATE THE RAINFALL TIME INTERVAL--DTM.
        IF(I.EQ.1) GO TO 11
        DTM=RAINT(I)-RAINT(I-1)
        GO TO 12
   11 DTM=RAINT(1)
   12 T=T+DTM
C      ---  CALCULATE THE POTENTIAL INFILTRATED VOLUME.
        DELF = DF(FO1,WET K(IPL),GAMMA,DTM)
C      ---  COMPUTE THE POTENTIAL AVERAGE INFILTRATION RATE.
        FD = DELF/DTM
```

```
      R=RAIN(I)
C     ---  COMPARE THE RAINFALL INTENSITY AND THE AVERAGE
C     ---  POTENTIAL INFILTRATION RATE. IF THE RAINFALL
C     ---  INTENSITY IS GREATER THAN THE INFILTRAION RATE
C     ---  THEN CALCULATE EXCESS. IF THE RAINFALL INTENSITY IS
C     ---  LESS THAN OR EQUAL TO THE INFILTRATION RATE THEN
C     ---  THE EXCESS IS ZERO.
      IF(FD.GT.R) THEN
      FD1S =R
      EXCES(I+1)= 0.0
      ELSE
      ITP=1
      FD1S=FD
      EXCES(I+1)=R-FD1S
      ENDIF
      EXCEST(I+1) =T
   25 FO1 = FO1+FD1S*DTM
      FO2=FO1
  105 CONTINUE
      EXCEST(NEX+1)=1.E20
C     NOTE: IN THE ORIGINAL VERSION THE EXCESS RATE AT THE NEXT STEP
C           WAS SET TO A NEGATIVE KW.  THIS MAY NOT BE THE BEST WAY
C           TO CONSIDER EXTENDED INFILTRATION.  IT IS NOW SET TO
C           A ZERO INFILTRATION RATE.  RE-COMMENT THE FOLLOWING LINES
C           IF YOU WISH TO CHANGE IT.
      EXCES(NEX+1) = 0.0
C     EXCES(NEX+1) = -WET K(IPL)
      NEX=NEX+1
C      ---  PRINT WARNING IF THERE IS NO EXCESS.
      IF(FIMP(IPL).GT.0.0.OR.ITP.NE.0) RETURN
   17 WRITE(6,10000)
      WRITE(*,10000)
10000 FORMAT(/' CUTOFF FINDS NO RAINFALL EXCESS.'/
     +' NO ROUTING WILL BE ATTEMPTED. CONTROL RETURNED TO'/
     +' ANAWAT.'/)
      ERR=2.0
      RETURN
      END
C
```

```
C     ***********************************************************
C
      FUNCTION DF(F,WK,HEAD,DT)
C
C      ---   EXPLICIT APPROXIMATION FOR GREEN-AMPT INFILTRATION
C      ---   MODEL DETERMINES THE POTENTIAL INFILTRATION
C      ---   VOLUME DURING TIME INCREMENT.
C
C      ---   PARAMETER DEFINITIONS.
C              F       = ACCUMULATED INFILTRATED VOLUME IN INCHES.
C              WK      = HYDRAULIC CONDUCTIVITY.
C              HEAD    = AV. SUCTION*POROSITY*(FINAL-INITIAL SATURATION)
C              DT      = TIME INCREMENT IN MINUTES.
C
      A=1.
      B=2.*F-WK*DT
      C=2.*WK*(HEAD+F)*DT
      DF=(-B+SQRT(B*B+4.*A*C))/(2.*A)
      RETURN
      END
C
```

```
C     ******************************************************************
C
      SUBROUTINE FORWRD(A,B,D,QIN,TIMEIN,N,OUTIME,TSTOP,FTIM,CHECK)
C
C     THIS SUBROUTINE IS USED TO PROPAGATE THE CHARACTERISTIC CURVES
C     IN A DOWNSLOPE (DOWNSTREAM) DIRECTION BEGINNING AT THE STARTING
C     TIME OF EACH EXCESS RAINFALL OR LATERAL INFLOW INCREMENT.  THE
C     METHOD USES AN ITERATIVE SOLUTION AND PROGRESSES FOR EACH
C     TIME STEP UNTIL THE DOWNSLOPE BOUNDARY IS INTERSECTED.  THE
C     INTERSECTION IS THE TIME OF ARRIVAL OF THAT CHARACTERISTIC.
C
C     KEY VARIABLES ARE:
C         QIN    = ARRRAY OF EXCESS RATES
C         D      = TOTAL LENGTH OF PLANE OR CHANNEL
C         X      = POSITION OF CHARACTERISTIC AT THE END OF A TIME STEP
C         DEPTH  = DEPTH OF FLOW AT A POINT ON THE CHARACTERISTIC
C         OUTIME = ARRAY OF ARRIVAL TIMES FOR THE CHARACTERISTICS,
C                  USED IN SUBROUTINE BACK
C
      DIMENSION QIN(200),TIMEIN(200),OUTIME(200)
C
      DO 10 K=1,200
         OUTIME(K)=0.0
   10 CONTINUE
      IFINAL=N-1
      IIFINL=IFINAL-1
      DO 200 K=1,IIFINL
         KK=K
         XPRE=0.
         X=0.
         DEPTH=0.
         DX=0.
         DO 100 I=K,IFINAL
            DT=TIMEIN(I+1)-TIMEIN(I)
            IF(QIN(I+1).EQ.0.0) GO TO 50
            IF(I.EQ.IFINAL) GO TO 80
            DEPTH=DEPTH+QIN(I+1)*DT
            IF(DEPTH.LE.0.0) DEPTH=0.0
            DUMX=DEPTH-QIN(I+1)*DT
            IF(DUMX.LE.0.0) DUMX=0.0
            DX=(A/QIN(I+1))*(DEPTH**B-DUMX**B)
            XPRE=X
      X=X+DX
      GO TO 60
50    CONTINUE
C     BECAUSE OF TRUNCATION ERRORS IN THE PC VERSION, THE FOLLOWING
C     DEPTH TRAPS WERE PUT IN THE MODEL TO CATCH SMALL NEGATIVE VALUES.
C
      IF(DEPTH.LE.0.0) DEPTH = 0.0
      DX=A*B*(DEPTH**(B-1.))*DT
            XPRE=X
            X=X+DX
   60    IF(X.LT.D) GO TO 100
            X=XPRE
```

```
            DEPTH=DEPTH-QIN(I+1)*DT
            IF(QIN(I+1).LE.0.0) GO TO 70
            IF(DEPTH.LE.0.0) DEPTH=0.0
            DELT=(((D-X)*QIN(I+1)/A+DEPTH**B)**(1./B)-DEPTH)/QIN(I+1)
            OUTIME(K)=DELT+TIMEIN(I)
            IF(OUTIME(K).LT.FTIM) GO TO 200
            TSTOP=FTIM
            RETURN
   70 CONTINUE
          IF(DEPTH.LE.0.0) DEPTH=0.0
          OUTIME(K)=(D-X)/(A*B*(DEPTH**(B-1.)))+TIMEIN(I)
            IF(OUTIME(K).LT.FTIM) GO TO 200
            TSTOP=FTIM
            RETURN
   80 CONTINUE
         IF(DEPTH.LE.0.0) DEPTH=0.0
         XMAX=X-(A*DEPTH**B)/QIN(I+1)
C     THIS IS THE POINT WHERE WE NEED TO SEE IF WE HAVE RUN OUT
C     OF TIME STEPS BEFORE WE HIT THE DOWNSLOPE BOUNDARY.  IF SO,
C     GO TO SUBROUTINE STOP.
            IF(XMAX.LT.D) GO TO 300
            IF(DEPTH.LE.0.0)DEPTH=0.0
            DELT=(((D-X)*QIN(I+1)/A+DEPTH**B)**(1./B)-DEPTH)/QIN(I+1)
            OUTIME(K)=TIMEIN(I)+DELT
            IF(OUTIME(K).LT.FTIM) GO TO 200
            TSTOP=FTIM
            RETURN
  100 CONTINUE
      IF(CHECK.EQ.0.0.AND.QIN(N).LT.0.0) GO TO 200
      IF(DEPTH.LE.0.0) GO TO 199
      OUTIME(K)=TIMEIN(IFINAL)+(D-X)/(A*B*(DEPTH**(B-1.)))
      IF(OUTIME(K).LT.FTIM) GO TO 200
      TSTOP=FTIM
      RETURN
  199 OUTIME(K)=1.E30
      TSTOP=FTIM
      RETURN
  200 CONTINUE
      IF(CHECK.EQ.1.0) GO TO 310
      IF(QIN(N).EQ.0.0) GO TO 310
      KK=IFINAL
  300 CONTINUE
      CALL STOP(A,B,D,QIN,TIMEIN,N,OUTIME,TSTOP,FTIM,KK,CHECK)
      RETURN
  310 OUTIME(IFINAL)=1.E30
      TSTOP=FTIM
      RETURN
      END
C
C     ***************************************************************
C
      SUBROUTINE STOP(A,B,D,QIN,TIMEIN,N,OUTIME,TSTOP,FTIM,K,CHECK)
C
```

```
C     THIS SUBROUTINE COMPLEMENTS THE FORWRD SUBROUTINE IN THAT
C     IT SOLVES FOR THE CHARACTERISTICS THAT ORIGINATE AFTER THE
C     EXCESS HYETOGRAPH OR LATERAL INFLOW HAS ENDED.
C
      DIMENSION QIN(200),TIMEIN(200),OUTIME(200)
      IFINAL=N-1
      IXNT=K-1
      IF(K.GT.1) GO TO 200
      DEPTH=0.0
      DO 100 I=2,IFINAL
         DEPTH=DEPTH+QIN(I)*(TIMEIN(I)-TIMEIN(I-1))
  100 CONTINUE
      OUTIME(1)=TIMEIN(IFINAL)-DEPTH/QIN(N)
      TSTOP=OUTIME(1)
      IF(OUTIME(1).GT.FTIM) TSTOP=FTIM
      RETURN
  200 CONTINUE
      DTT=(TIMEIN(K)-TIMEIN(IXNT))/2.
      TIME1=TIMEIN(IXNT)+DTT
      IIFINL=IFINAL-1
      IF(CHECK.EQ.1.0) IIFINL=IFINAL
  300 CONTINUE
      DEPTH=0.
      X=0.
      DO 400 I=IXNT,IIFINL
         II=I
         IF(I.NE.IXNT) GO TO 410
         DT=TIMEIN(K)-TIME1
         GO TO 420
  410 DT=TIMEIN(I+1)-TIMEIN(I)
  420 IF(QIN(I+1).EQ.0.0) GO TO 430
         DEPTH=DEPTH+QIN(I+1)*DT
         IF(DEPTH.LE.0.0) DEPTH = 0.0
         DUMX=DEPTH-QIN(I+1)*DT
         IF(DUMX.LE.0.0) DUMX=0.0
         DX=(A/QIN(I+1))*(DEPTH**B-DUMX**B)
         X=X+DX
         IF(X.GE.D) GO TO 435
         GO TO 400
  430 CONTINUE
         IF(DEPTH.LE.0.0) DEPTH = 0.0
         DX=A*B*(DEPTH**(B-1.))*DT
         X=X+DX
         IF(X.GE.D) GO TO 435
  400 CONTINUE
      IF(CHECK.EQ.1.0) GO TO 435
      IF(DEPTH.LE.0.0) DEPTH = 0.0
      XMAX=X-(A*DEPTH**B)/QIN(N)
      IF(XMAX.LT.D) GO TO 440
      CON=(XMAX-D)/D
      IF(CON.LT.0.05) GO TO 500
  435 DTT=DTT/2.

      TIME1=TIME1+DTT
```

```
      IF(CHECK.EQ.0.0) GO TO 300
      DEPTH=DEPTH-QIN(II+1)*DT
      IF(DEPTH.LE.0.0) DEPTH = 0.0
      IF(QIN(II+1).EQ.0.0) GO TO 438
      DELT=(((D-X)*QIN(II+1)/A+DEPTH**B)**(1./B)-DEPTH)/QIN(II+1)
      GO TO 439
  438 CONTINUE
      IF(DEPTH.LE.0.0) DEPTH = 0.0
      OUTIME(K)=(D-X)/(A*B*(DEPTH**(B-1.)))+TIMEIN(II)
      OUTIME(K)=TIMEIN(II)+DELT
  439 CONTINUE
      IF(OUTIME(K).LT.FTIM) GO TO 300
      TSTOP=FTIM
      GO TO 550
  440 DTT=DTT/2.
      TIME1=TIME1-DTT
      GO TO 300
  500 CONTINUE
      IF(DEPTH.LE.0.0) DEPTH = 0.0
      DELT=(((D-X)*QIN(N)/A+DEPTH**B)**(1./B)-DEPTH)/QIN(N)
      OUTIME(K)=TIMEIN(II+1)+DELT
      IF(II.EQ.IXNT)OUTIME(K)=TIME1+DELT
      TSTOP=OUTIME(K)
      IF(TSTOP.GT.FTIM)TSTOP=FTIM
  550 DUMQ=QIN(K)
      N=N+1
      DO 600 I=K,N
      DUM1=TIMEIN(I)
         TIMEIN(I)=TIME1
         TIME1=DUM1
         DUM2=QIN(I)
         QIN(I)=DUMQ
         DUMQ=DUM2
  600 CONTINUE
      RETURN
      END
C
```

```
C      ****************************************************************
C
         SUBROUTINE BACK (AL,BET,LEN,DTIM,TSTOP,TL,T,Q,QOUT,NQ,CHECK)
C
C             THIS SUBROUTINE USES THE SUBDIVIDED SOLUTION DOMAIN
C             AS SUPPLIED BY SUBROUTINE FORWRD TO CALCULATE THE
C             TIME OF ORIGIN OF CHARACTERISTICS CORRESPONDING TO
C             AN ARBITRARILY SELECTED TIME ON THE DOWNSTREAM
C             BOUNDARY.  IN SHORT, BACK CALCULATES CHARACTERISTICS
C             IN THE UPSTREAM DIRECTION.  THIS ALLOWS THE DISCHARGE
C             TO BE KNOWN AT CONVENIENT TIME INTERVALS THEREBY
C             FACILITATING THE FORMATION OF THE LATERAL INFLOW TO
C             THE CHANNEL AND ALLOWING GREATER EASE IN INTERFACING
C             THIS WATER ROUTING SIMULATION WITH OTHER WATERSHED
C             PROCESS MODELS.
C             SUBROUTINE BACK PROCEEDS AS FOLLOWS:
C             IT FIRST DETERMINES THE LOCATION OF THE TIME OF INTEREST
C             ON THE DOWNSTREAM BOUNDARY WITH RESPECT TO THE
C             CHARATERISTICS SUPPLIED BY SUBROUTINE FORWRD.  NEXT,
C             THE ROUTINE FORMULATES F(TO) AND ITS FIRST TWO
C             DERIVATIVES, FINALLY, THIS RESULT IS ITERATED
C             UNTIL A SUITABLY ACCURATE ESTIMATE OF THE TIME OF
C             ORIGIN IS CALCULATE USING A SECOND ORDER NEWTONS METHOD.
C
C             PARAMETER DEFINITIONS
C               AL      = A IN Q=A*Y**B.
C               BET     = B IN Q=A*Y**B.
C               LEN     = SLOPE LENGTH (FT).
C               DTIM    = TIME INCREMENT FOR HYDROGRAPH (SEC).
C               FTIM    = ENDING TIME OF HYDROGRAPH (SEC).
C               TL      = ARRAY OF FINAL TIMES FOR THE CHARACTERISTIC
C                         LINES FOUND IN FORWRD SUBROUTINE (SEC).
C               T       = TIME ARRAY FOR INFLOW (SEC).
C               Q       = INFLOW ARRAY (FT/SEC OR CFS/FT).
C               QOUT    = OUTFLOW DISCHARGES (CFS/FT OR CFS).
C               NQ      = NUMBER OF INCREMENTS IN INFLOW.
C               TSTOP   = TIME WHEN RUNOFF STOPS.
C
           COMMON /DEPTH/ Y(200)
           DIMENSION TL(200),T(200),Q(200),CUMQ(200),QOUT(200)
C
           REAL LEN
C           ONE TIME INITIALIZATION OF LOOP PARAMETERS AND TIMES.
           EPQ = 1.E - 5
           IF (CHECK.EQ.1.) EPQ = 1.E - 5 * LEN
           NITER = 10
           EP = 0.0001
           TIME = 0.
           B1 = BET - 1.
           B2 = BET - 2.
           B3 = BET - 3.
           Y(1) = 0.0
C          CALCULATE CUMLATIVE INFLOW ARRAY.
           TOT = Q(1) * T(1)
```

```
            CUMQ(1) = TOT
      TEST=0.0
            DO 100 I = 2,200
               TOT = TOT + Q(I) * (T(I) - T(I - 1))
               CUMQ(I) = TOT
               Y(I) = 0.0
  100 CONTINUE
            I = 1
  110 IF (TL(I).NE.TL(I + 1)) GO TO 120
            I = I + 1
            GO TO 110
C            THIS LOOP ITERATES FINAL TIMES FROM 0.0 TO FTIM. FOR
C            EACH FINAL TIME AN INITIAL TIME (TEST) IS CALCULATED.
  120       CONTINUE
      DO 300 J = 2,200
               TPRE=TEST
               TIME = TIME + DTIM
               IF (TIME.GT.TSTOP) RETURN
C            THIS SECTION IS USED TO CALCULATE THE DISCHARGE FOR
C            ALL TIMES LESS THAN TL(1).  FOR THESE TIMES IT IS NOT
C            NECESSARY GO CALCULATE THE UPSTREAM TIME OF THE CHARACTERIS
C            SINCE ALL OF THESE CHARACTERISTICS BEGIN AT T=0.
               IF (TIME.LE.TL(1)) THEN
               DUMYT = 0.0
               CALL ITEGR (DUMYT,TIME,DEPTHX,Q,T,NQ)
               QOUT(J) = AL * DEPTHX *  * BET
               Y(J) = DEPTHX
               GO TO 300
               ENDIF
  130    IK = I
C            FIND THE BOUNDS FOR THE CHARACTERISTIC LINE.
               DO 140 IJ = IK,200
                  IF (TIME.LE.TL(IJ + 1)) GO TO 150
                  I = I + 1
  140    CONTINUE
  150    L2 = I
C            IF THE LATERAL INFLOW INTENSITY IS EQUAL TO ZERO,
C            IT IS NECESSARY TO SKIP UP TO THE NEXT CHARACTERISTIC.
               IF (Q(L2 + 1).NE.0.) GO TO 160
               I = I + 1
               GO TO 150
  160    CALL INDX(TIME,L,NQ,T)
               M = L - L2 - 1
C            THE FIRST GUESS OF THE TIME OF ORIGIN TO BE CALCULATED
C            (TEST) IS THE AVERAGE OF THE TIME OF ORIGIN OF
C            THE LOWER BOUNDING CHARACTERISTIC, AND THE SMALLER OF
C            THE TIME ORIGIN OF THE UPPER BOUNDING CHARACTERISTIC
C            AND TIME.
               TUP = T(I + 1)
      TDN=T(I)
      IF(TPRE.GT.TDN)TDN=TPRE
               IF (TUP.GT.TIME) TUP = TIME
               TEST = (TDN + TUP)/2.
C            THIS IS AN ANALYTICAL SOLUTION USING A THIRD ORDER
```

```
C           NEWTON APPROXIMATION TO SOLVE FOR THE CHARACTERISTIC LINE.
              DO 281 J1 = 1,NITER
                 FF =  - LEN/(AL * BET)
                 FTO = FF
                 TLAST = TEST
                 IF (M.EQ.0) THEN
                 TEST = TIME
     +                - ((LEN/(AL * (Q(L) *  * B1))) *  * (1./BET))
                 GO TO 290
                 ENDIF
                 IF (M.EQ.1) GO TO 190
                 C1 = Q(L2 + 1) * T(L2 + 1) - Q(L2 + 1) * TEST
                 FTO = FTO + (1./(Q(L2 + 1) * BET)) * (C1 *  * BET)
                 FDTO =  - (C1 *  * B1)
                 FD2TO = Q(L2 + 1) * B1 * (C1 *  * B2)
                 DO 180 J2 = 2,M
                    JJ = L2 + J2
                    A =  - Q(JJ) * T(JJ - 1) + CUMQ(JJ - 1) - CUMQ(L2)
     +                + Q(L2 + 1) * T(L2)
                    IF (Q(JJ).EQ.0.) THEN
                    C1=-Q(L2+1)*TEST+A
                    CDT=T(JJ)-T(JJ-1)
                    FTO=FTO+CDT*(C1**B1)
                    FDTO=FDTO+B1*(-Q(L2+1))*CDT*(C1**B2)
                    FD2TO=FD2TO+B1*B2*Q(L2+1)*Q(L2+1)*CDT*(C1**B3)
                    ELSE
                    C1 = Q(JJ) * T(JJ) - Q(L2 + 1) * TEST + A
                    C2 = Q(JJ) * T(JJ - 1) - Q(L2 + 1) * TEST + A
                    FTO = FTO + (1./(BET * Q(JJ))) * ((C1 *  * BET)
     +                 - (C2 * * BET))
                    FDTO = FDTO + ( - Q(L2 + 1)/Q(JJ)) * ((C1 *  * B1)
     +                  - (C2*  * B1))
                    FD2TO = FD2TO + (Q(L2 + 1) * Q(L2 + 1)/Q(JJ)) * B1
     +                   * ((C1*  * B2) - (C2 *  * B2))
                    ENDIF
  180            CONTINUE
C
  190       A =  - Q(L) * T(L - 1) + CUMQ(L - 1) - CUMQ(L2) + Q(L2 + 1)
     +           * T(L2)
                 IF (Q(L).NE.0.) GO TO 200
                 C1 = A - Q(L2 + 1) * TEST
                 CDT = TIME - T(L - 1)
                 FTO = FTO + CDT * (C1 *  * B1)
                 FDTO = FDTO + CDT * B1 * ( - Q(L2 + 1)) * (C1 *  * B2)
                 FD2TO = FD2TO + CDT * B1 * B2 * Q(L2 + 1) * Q(L2 + 1)
     +                * (C1*  * B3)
                 GO TO 220
  200       C1 = Q(L) * TIME - Q(L2 + 1) * TEST + A
                 C2 = Q(L) * T(L - 1) - Q(L2 + 1) * TEST + A
                 IF (C1.LT.0.0.OR.C2.LT.0.0) GO TO 260
                 FTO = FTO + (1./(Q(L) * BET)) * ((C1 *  * BET)
     +             - (C2 *  * BET))
                 FDTO = FDTO + ( - Q(L2 + 1)/(Q(L))) * ((C1 *  * B1)
     +               - (C2 *  * B1))
```

```
                FD2TO = FD2TO + ((Q(L2 + 1) * Q(L2 + 1))/Q(L)) * B1
     +                 *((C1 *  *B2) - (C2 * * B2))
                GO TO 220
C
C          TEST FOR CONVERGENCE.  IF TEST IS SUCCESSFUL, THE
C          ITERATIONS ARE COMPLETE.  THE PROGRAM THEN PROCEEDS TO
C          THE NEXT TIME INCREMENT.  IF NOT, THE PROGRAM USES
C          THE SOLUTION TO A TRUNCATED TAYLOR'S SERIES TO CALCULATE
C          A NEW TRIAL VALUE OF TEST.
  220      IF (ABS(FTO/FF).LE.EP) GO TO 290
                B = (2. * FDTO/FD2TO) - (2. * TEST)
                C = (2./FD2TO) * (FTO - FDTO * TEST
     +              + 0.5 * TEST * TEST * FD2TO)
                D = B * B - 4. * C
                IF (D.LT.0.) GO TO 230
                DTEST = 0.5 * SQRT(D)
                GO TO 240
C
C          THE NEW ESTIMATE OF TEST MUST FALL INSIDE THE REGION
C          OF THE SOLUTION DOMAIN BOUNDED BY THE CHARACTERISTICS
C          SELECTED ABOVE.  IF IT DOES NOT, THEN AN ESTIMATE MUST
C          BE REPICKED INSIDE THAT REGION.  THIS PROCEDURE MAY
C          RESULT IN THE REJECTION OF THE ESTIMATE PROVIDED BY
C          THE NEWTON)S METHOD.  AND THE SUBSTITUTION OF A NEW
C          NEW AVERAGE VALUE AS THE NEW GUESS OF TEST.
  230      CONTINUE
      TEST = TEST - FTO/FDTO
                IF (TEST.LT.TUP.AND.TEST.GE.TDN) GO TO 280
                GO TO 250
  240      DTEST = 0.5 * (SQRT(B * B - 4. * C))
                IF (ABS(FTO/FF).LE.EP) GO TO 290
                TEST = 0.5 * ( - B) - DTEST
                IF (TEST.LT.TUP.AND.TEST.GT.TDN) GO TO 241
                TEST = 0.5 * ( - B) + DTEST
                IF (TEST.LT.TUP.AND.TEST.GE.TDN) GO TO 280
                TEST = TLAST
                GO TO 230
  241           TESTB=.5*(-B)+DTEST
      IF(TESTB.GT.TUP.OR.TESTB.LT.TDN) GO TO 280
      TESTC=TLAST-FTO/FDTO
      TEST1=ABS(TESTC-TEST)
      TEST2=ABS(TESTC-TESTB)
      IF(TEST1.GT.TEST2)TEST=TESTB
      IF(TEST.LT.TUP.AND.TEST.CT.TDN) GO TO 280
      TEST=TLAST
      GO TO 230
  250      IF (TEST.GE.TUP) GO TO 270
  260      TEST = (TLAST + TDN)/2.
                GO TO 280
  270      TEST = (TLAST + TUP)/2.
  280   CONTINUE
  281   CONTINUE
C
C          THE VALUES OF DEPTH (OR CROSS-SECTIONAL AREA FOR CHANNELS)
```

```
C          AND DISCHARGE ARE NOW CALCULATED. A TEST IS MADE TO CHECK
C          IF THE DISCHARGE IS NEGLIGIBLY SMALL OR IF THE PRESELECTED
C          DURATION OF THE HYDROGRAPH HAS BEEN EXCEEDED.  IF SO THE
C          ROUTINE RETURNS TO ANAWAT.
  290      CONTINUE
          CALL ITEGR (TEST,TIME,DEPTHX,Q,T,NQ)
             QOUT(J) = AL * DEPTHX *  * BET
             Y(J) = DEPTHX
             NP = NQ
             IF (CHECK.GT.0.) NP = NQ + 1
             IF (TIME.GE.T(NQ - 1).AND.QOUT(J).LE.EPQ) RETURN
  300    CONTINUE
            RETURN
            END
C
```

```
C     ****************************************************************
C
      SUBROUTINE ITEGR(T1,T2,ANS,QIN,TIMEIN,N)
C
C      ---  SUBROUTINE INTEGR INTEGRATES THE EXCESS
C      ---  RAINFALL (OR INFLOW IN THE CASE OF A CHANNEL)
C      ---  HISTOGRAM BETWEEN AN INITIAL TIME (T1)
C      ---  AND A FINAL TIME (T2).
C
C      ---  PARAMETER DEFINITIONS.
C             T1     = INITIAL TIME OF CHARACTERISTIC.
C             T2     = FINAL TIME OF CHARACTERISTIC.
C             ANS    = AREA BETWEEN T1 AND T2 OF IN ARRAY.
C             QIN    = ARRAY BEING INTEGRATED.
C             TIMEIN = ARRAY OF FINAL TIMES CORRESPONDING TO THE
C                      QIN ARRAY.
C             N      = NUMBER OF ELEMENTS IN QIN AND TIMEIN ARRAYS.
C
      DIMENSION QIN(200),TIMEIN(200)
C
C      ---  INITIALIZE DUMMY VARIABLE WHICH IS USED
C      ---  TO STORE INTERMEDIATE ANSWERS.
      CUM =0.
C      ---  FIND INITIAL TIME INCREMENT.
      DO 100 I=2,N
      II=I
        IF(T1.LT.TIMEIN(I)) GO TO 55
  100 CONTINUE
   55 IXNT=II
C      ---  FIND FINAL TIME INCREMENT.
      DO 101 I=IXNT,N
        IF(T2.GE.TIMEIN(I)) GO TO 101
        IFIN=I
        GO TO 40
  101 CONTINUE
      IFIN=N
C      ---  FIND AREA INBETWEEN INITIAL AND FINAL
C      ---  TIME INCREMENTS.
   40 CONTINUE
       DO 102 J=IXNT,IFIN
        CUMPRE=CUM
        CUM=CUM+(TIMEIN(J)-TIMEIN(J-1))*QIN(J)
      IF(J.EQ.IFIN) CUM=CUMPRE+QIN(J)*(T2-TIMEIN(J-1))
  102 CONTINUE
C      ---  CORRECT INTERMEDIATE ANSWER BY SUBTRACTING
C      ---  THE AREAS WHICH SHOULD NOT BE INCLUDED.
      IF(T1.NE.0.0) CUM=CUM-(T1-TIMEIN(IXNT-1))*QIN(IXNT)
C      ---  SET VALUE OF FINAL ANSWER.
       ANS=CUM
      RETURN
      END
C
C     ****************************************************************
C
```

```
      SUBROUTINE INDX(TIME,L,NQ,T)
C
C      ---  THIS SUBROUTINE LOCATES WHICH INFLOW TIME INCREMENT (L)
C      ---  CONTAINS A GIVEN TIME (TIME).
C      ---  PARAMETER DEFINITIONS.
C             TIME    = TIME OF INTEREST.
C             L       = INDEX OF T ARRAY CONTAINING THE  TIME.
C             NQ      = NUMBER OF INFLOW TIME INCREMENTS.
C             T       = ARRAY OF INFLOW TIME INCREMENTS (SEC).
C
      DIMENSION T(200)
C
      DO 100 I=1,NQ
        L=I
        IF(TIME.LE.T(I)) GO TO 10
  100 CONTINUE
      L=NQ+1
   10 RETURN
      END
C
```

```
C     ****************************************************************
C
      SUBROUTINE QLAT(QL,QLT,QLTIME,DTIM,KF)
C
C      ---  THIS SUBROUTINE USED ONLY IN THE 2 PLANES AND
C      ---  1 CHANNEL CASE.  IT TOTALS THE LATERAL INFLOW
C      ---  INTO THE CHANNEL.
C
C      ---  PARAMETER DEFINITIONS.
C             QL     = DOUBLE DIMENSION ARRAY CONTAINING THE
C                      OUTFLOWS FROM EACH CHANNEL.
C             QLT    = ARRAY OF THE TOTAL LATERAL INFLOW.
C             QLTIME = ARRAY OF THE TIMES FOR THE TOTAL LATERAL
C                      INFLOW (QLT ARRAY).
C             DTIM   = TIME INCREMENT USED (SEC).
C             KF     = NUMBER OF ELEMENTS IN TIME ARRAY.
C
      DIMENSION QL(200,2),QLT(200),QLTIME(200)
C
C      ---  CALUCULATE THE TOTAL AVERAGE INFLOW OVER A GIVEN TIME
C      ---  PERIOD.
      QLT(1)=0.0
      QLTIME(1)=0.0
      KFF=KF+1
      DO 105 I=2,KFF
        QLT(I)=(QL(I,1)+QL(I,2)+QL(I-1,1)+QL(I-1,2))/2.
        QLTIME(I)=QLTIME(I-1)+DTIM
  105 CONTINUE
      KFF=KFF+1
      KF=KFF
      QLT(KFF)=0.0
      QLTIME(KFF)=QLTIME(KFF-1)+1.E30
      RETURN
      END
C
```

```
C     ****************************************************************
C
           SUBROUTINE RESIST(XN,A1,B1,ALP,BET,SLP)
C
C      ---  THIS SUBROUTINE CALCULATES THE PARAMETERS A AND
C      ---  B IN THE EQUATION Q=A*AREA**B.
C
C      ---  THIS IS FOR THE MANNINGS RESISTANCE.
           BET=(5.-2.*B1)/3.
           ALP=((SLP*2.21)/(XN*XN*A1**(4./3.)))**.5
           RETURN
           END
C
```

```
C     ***************************************************************
C
       SUBROUTINE TRANSP(ID,I,SLOPE,PLNGTH,NRAIN,RT,RAIN,R,Q,QL,
     +                  DTIM,FTIM,VISCO,A1,B1,YIELD,TYIELD)
C
C        SUBROUTINE TRANSP CALCULATES THE SEDIMENT YIELD BY SIZE
C        FOR THE PLANE UNITS AND THE CHANNEL UNITS (ID=0,1 OR 2).
C        ----- FOR THE PLANE UNITS ID=0 (SINGLE) OR 1(WATERSHED)
C        THE DECIMAL PERCENT OF GROUND AND CANOPY COVER IS USED TO
C        ESTIMATE THE OVERLAND FLOW ROUGHNESS. RAINDROP SPLASH AND
C        OVERLAND FLOW ARE USED TO ESTIMATE THE AMONT OF MATERIAL
C        AVAILABLE FOR  TRANSPORT AND THE AMOUNT THAT CAN BE TRANS-
C        PORTED.  RILL AND GULLY DEVELOPMENT ARE NOT CONSIDERED.
C        ----- FOR THE CHANNEL UNITS ID=2
C        THIS SUBROUTINE CALCULATES THE AMOUNT OF SEDIMENT GENERATED
C        IN THE CHANNEL UNIT OF A WATERSHED DUE TO THE INFLOW FROM
C        FROM THE PLANES.  THE TOTAL SEDIMENT INFLOW FROM THE PLANES
C        IS CALCULATED AS TSDLAT.  THE  INFLOW FOR EACH SIZE FRACTION
C        IS DETERMINED AS SEDLAT.  THE TOTAL TRANSPORT CAPACITY FOR
C        EACH SIZE (TSEDQ) IS INITIALIZED.
C
      COMMON/DEPTH/ Y(200)
      COMMON/SED/ DCOEFF,DPOW,DOF,CHDOF,TAOCK,NSED,PSI(10),DMBI(10)
      COMMON/SOIL/ WET K(2),POROS(2),SAVE(2),SW(2),SI(2),
     +            PLASI(3),COHM(3)
      COMMON/COVER/ GRNCOV(2),CANCOV(2),VG(2),VC(2),FIMP(2),SLOOSE(2)
      DIMENSION Q(200),YIELD(10,3),SEDLAT(10),SEDQ(10),TSEDQ(10),
     +         SLOPE(3),PLNGTH(3),RAIN(200),RT(200),TYIELD(3),QL(200)
C
C     DO SOME PRE-COMPUTATIONS BEFORE YOU START THE SEDIMENT LOOPS
      IF(ID.LE.1) THEN
C     THIS IS FOR THE PLANE UNITS
            CG = GRNCOV(I)/100.
            CC = CANCOV(I)/100.
            REPOSE = 0.84
C       INITIALIZE VARIABLES.
            FI = FIMP(I)
            TSDLAT = 0.0
C       CALCULATE THE AMOUNT OF SEDIMENT DETACHED FROM RAINFALL.
            AR1 = 1.-CG-FI+CG*FI
            AR2 = AR1*(1-CC)
            DAREA = AR2*PLNGTH(3)*PLNGTH(I)
            WTFAC = DAREA*(1.-POROS(I))*2.65*62.4/12.
            RTPRE = 0.0
            DO 55 J=1,NRAIN
               DQ = DCOEFF*(RAIN(J)*60.)**DPOW
               TSDLAT = TSDLAT + DQ*(RT(J)-RTPRE)/60.
               RTPRE = RT(J)
   55       CONTINUE
           TSDLAT = TSDLAT*WTFAC + SLOOSE(I)
      ELSEIF (ID.EQ.2) THEN
C     THIS IS FOR THE CHANNEL CASE
      TSDLAT=0.0
      DO 65 ISED=1,NSED
```

```
        SEDLAT(ISED)=YIELD(ISED,1)+YIELD(ISED,2)
        TSDLAT=TSDLAT+SEDLAT(ISED)
   65 CONTINUE
      ENDIF
           SSEDQ=0.0
           DCOH=0.0
           T=0.0
           DMBMAX = -1000.0
           DO 75 IJ=1,NSED
               SEDQ(IJ)=0.0
               TSEDQ(IJ)=0.0
               IF(DMBI(IJ).GE.DMBMAX) DMBMAX = DMBI(IJ)
   75      CONTINUE
C
C       LOOP 110 CALCULATES THE TRANSPORT CAPACITY FOR ALL THE SIZE
C       FRACTIONS FOR EACH CALCULATED DISCHARGE.
           DO 110 IJ=2,200
               T=T+DTIM
               IF(T.GT.FTIM) GO TO 121
               IF(ID.EQ.0.OR.ID.EQ.2) QQ = Q(IJ)
               IF(ID.EQ.1) QQ = QL(IJ)
               IF (QQ.EQ.0.0) GO TO 110
      IF(ID.LE.1) THEN
C       CALCULATE THE DEPTH OF FLOW AND MEAN VELOCITY
              DEPTHP = (QQ*R*VISCO/(257.6*SLOPE(I)))**(1./3.)
              VMEAN = QQ/DEPTHP
C       EFFECTIVE SHEAR STRESS:
              TAO=.24225*45.*VISCO*QQ/(DEPTHP**2.)
          IF(PLASI(I).GT.0.0) THEN
              TCOH=0.0022*PLASI(I)**0.82
              ERATE=COHM(I)*(TAO/TCOH-1.)
              IF(ERATE.LE.0.0) ERATE = 0.0
              DCOH=DCOH+ERATE
          ENDIF
              SUMPS=0.0
          SK=COS(ATAN(SLOPE(I)))*SQRT(1.-(SLOPE(I)/REPOSE)**2)
      ELSEIF (ID.EQ.2) THEN
C       THIS SECTION CALCULATES THE CHANNEL CROSS-
C       SECTIONAL AREA AND TOP WIDTH.
C       THE CROSS-SECTIONAL AREA IS TRANSFERRED AS Y(IJ)
      CHAR=Y(IJ)
      WPER=A1*CHAR**B1
      HYRAD=CHAR/WPER
      VMEAN=QQ/CHAR
      TAO=62.4*SLOPE(I)*HYRAD
      IF(PLASI(I).GT.0.0) THEN
         TCOH=0.0022*PLASI(I)**.82
         ERATE=COHM(I)*(TAO/TCOH-1.)*WPER
         IF(ERATE.LT.0.0) ERATE=0.0
         DCOH=DCOH+ERATE
      ENDIF
               SUMPS = 0.
      FMAX=1.69+2.*ALOG10(2.*HYRAD/DMBMAX)
      IF(FMAX.EQ.0.0) FMAX=0.0000001
```

```
      FMAX=1.5/(FMAX)**2
      IF(FMAX.GT.0.10)FMAX=0.10
      IF(FMAX.LT.0.010) FMAX=0.010
      FMIN = FMAX/2.
      ENDIF
C
C       THE 111 LOOP CALCULATES THE BED LOAD AND SUSPENDED
C       LOAD TRANSPORT FOR EACH SIZE FRACTION.
               DO 111 ISED=1,NSED
                  DMB=DMBI(ISED)
                  PS=PSI(ISED)
C       CRITICAL SHEAR STRESS:
      IF(ID.LE.1) THEN
C      THIS IS FOR THE PLANE CASE
                 TAOC=102.96*TAOCK*DMB*SK
                 IF (TAO.GT.TAOC) GO TO 106
                 SEDQ(ISED)=0.
                 SUSP=0.
                 GO TO 108
      ELSEIF (ID.EQ.2) THEN
C      THIS IS FOR THE CHANNEL CASE
                 FDIVR=1.69+2.*ALOG10(2.*HYRAD/DMB)
                 IF(FDIVR.EQ.0.0) FDIVR=0.0000001
                 F=1.5/(FDIVR)**2
                 IF(F.GT.FMAX)F=FMAX
                 IF(F.LT.FMIN) F=FMIN
                 TAO=.2425*F*VMEAN*VMEAN
                 TAOC=102.96*TAOCK*DMB
C       CHECK TO SEE IF EXCESS SHEAR EXISTS
                  IF (TAO.GT.TAOC) GO TO 106
                  SEDQ(ISED)=0.
                  SUSP = 0.
                  GO TO 108
      ENDIF
C
C       BED LOAD CALCULATION USING THE MEYER-PETER,MUELLER EQUATION
  106        SEDQ(ISED)=(12.85/1.392)*(TAO-TAOC)**(1.5)
C       SHEAR VELOCITY:
              IF(ID.LE.1) THEN
                  SV=SQRT(62.4*DEPTHP*SLOPE(I)/1.938)
              ELSEIF (ID.EQ.2) THEN
                  SV=SQRT(62.4*HYRAD*SLOPE(3)/1.938)
              ENDIF
C       FALL VELOCITY CALCULATION
                  IF(DMB.GT.0.0002) THEN
                  FVB=(SQRT(36.064*DMB**3.+36.*VISCO**2.)-6.*VISCO)/DMB
                  ELSE
                  FVB=2.9517*DMB**2./VISCO
                  ENDIF
C       CALCULATE PARAMETERS FOR EINSTIEN'S SUSPENDED
C       SEDIMENT LOAD APPROXIMATION.
                ZR=FVB/(0.4*SV)
                BMV=2.5+VMEAN/SV
             IF(ID.LE.1) THEN
```

```
                 AR=2.*DMBMAX/DEPTHP
                 IF(AR.LT..04) AR=.04
                 IF (ZR.GT.5.5.OR.AR.GT.0.5) GO TO 107
              ELSEIF (ID.EQ.2) THEN
                  AR=2.*DMBMAX/HYRAD
                  IF (AR.GT.0.9) GO TO 107
              ENDIF
C       EVALUATE J1 AND J2.
                  CALL POWER (ZR,AR,FJ,SJ,1.0E-2)
                  P=AR**(ZR-1.)/(11.6*(1.-AR)**ZR)
                  SUSP=P*(BMV*FJ+2.5*SJ)
                  SUPMAX=1./AR
                  IF(SUSP.GT.SUPMAX) SUSP=SUPMAX
                  IF (SUSP.LE.0.0) SUSP=0.0
                  GO TO 108
 107         SUSP=0.
 108         CONTINUE
C
C       CALCULATE THE TOTAL SEDIMENT TRANSPORT CAPACITY FOR THIS
C       SIZE FRACTION(TSEDQ). UPDATE TRANSPORTING CAPACITY FOR
C       FOR THIS SIZE FRACTION AT THIS TIME INCREMENT FOR SUSPEN-
C       DED SEDIMENT. UPDATE THE TOTAL TRANSPORT RATE  FOR THIS
C       TIME INCREMENT.
               IF(ID.LE.1) THEN
                  WX = 1.0 * AR1
                  PLX = PLNGTH(3)
               ELSEIF (ID.EQ.2) THEN
                  WX = WPER
                  PLX = 1.0
               ENDIF
                  SEDQ(ISED)=(1.+SUSP)*SEDQ(ISED)*WX*PS
                  TSEDQ(ISED)=TSEDQ(ISED)+SEDQ(ISED)*PLX*DTIM
                  SUMPS=SUMPS+SEDQ(ISED)
 111         CONTINUE
C       CALCULATE THE TOTAL SEDIMENT TRANSPORT CAPACITY
C       FOR ALL SIZES.
               SSEDQ=SSEDQ+SUMPS*DTIM*PLX
 110      CONTINUE
 121 CONTINUE
     IF(ID.LE.1) THEN
C       CALCULATE THE DETACHED SEDIMENT FROM OVERLAND FLOW.
           DCOH=DCOH*DTIM*PLNGTH(3)*PLNGTH(I)
           DA=DOF*(SSEDQ - TSDLAT)
     ELSEIF (ID.EQ.2) THEN
C       CALCULATE THE DETACHED SEDIMENT FROM CHANNEL FLOW.
           DCOH=DCOH*DTIM*PLNGTH(3)
           DA=CHDOF*(SSEDQ-TSDLAT)
     ENDIF
           IF (DA.LT.0.0) DA=0.0
           IF(PLASI(I).GT.0.0.AND.DA.GT.DCOH) DA=DCOH
           IF(ID.LE.1) DA = TSDLAT + DA
C
C       REDISTRIBUTE THE AVAILABLE SEDIMENT IN PROPORTION TO THE
C       PARENT MATERIAL THEN COMPUTE THE YIELD FOR EACH SIZE.
```

```
      TYIELD(I) = 0.0
      DO 220 ISED=1,NSED
          IF(ID.LE.1) THEN
            SEDX = 0.0
          ELSEIF (ID.EQ.2) THEN
            SEDX = SEDLAT(ISED)
          ENDIF
          SEDAV=SEDX + PSI(ISED)*DA
          YIELD(ISED,I) = TSEDQ(ISED)
          IF(TSEDQ(ISED).GT.SEDAV) YIELD(ISED,I) = SEDAV
          TYIELD(I) = TYIELD(I) + YIELD(ISED,I)
220   CONTINUE
      RETURN
      END
C
```

```
C      ******************************************************************
C
            SUBROUTINE POWER (Z,A,XJ1,XJ2,CONV)
C
C       THIS SUBROUTINE EVALUATES THE J1 AND J2 INTEGRALS IN THE
C       EINSTEIN APPROXIMATION.
C       XJ1 AND XJ2 EQUAL THE J1 AND J2 INTEGRAL RESPECTIVLY
C       N=ORDER OF APPROXIMATION +1
C       CONV= CONVERGENCE CRITERION
          N=1
          XJ1=0.
          XJ2=0.
          ALG=ALOG(A)
          C=1.
          D=-Z
          E=D+1.
          FN=1.
          AEX=A**E
          GO TO 102
  101 N=N+1
          C=C*D/FN
          D=E
          E=D+1.
          FN=FLOAT(N)
          AEX=A**E
  102 IF (ABS(E).LE.0.001) GO TO 103
          XJ1=XJ1+C*(1.-AEX)/E
          XJ2=XJ2+C*((AEX-1.)/E**2-AEX*ALG/E)
          GO TO 104
  103 XJ1=XJ1-C*ALG
          XJ2=XJ2-0.5*C*ALG**2
  104 IF (N.EQ.1) GO TO 105
          CJ1=ABS(1.-FJ1/XJ1)
          CJ2=ABS(1.-FJ2/XJ2)
          IF (CJ1.LE.CONV.AND.CJ2.LE.CONV) RETURN
  105 FJ1=XJ1
          FJ2=XJ2
          GO TO 101
          END
C
```

```
C     ****************************************************************
C
      SUBROUTINE OUT(ISEG,YIELD,Q,NUM,QT,TAREA,TVINTR,NSED,DTIM,
     +               DMBI,TYIELD,TRVOL,ID)
C
C     THIS SUBROUTINE CONTROLS OUTPUT TO THE SCREEN AND TO
C     THE DISK FILE SCREEN1.OUT.
C
      COMMON/VAR1/ TITL
      DIMENSION YIELD(10),Q(201),DMBI(10),TITL(3)
C
      WRITE(6,99)
      WRITE(*,99)
   99 FORMAT(//////////)
      WRITE(6,100)ISEG,(TITL(I),I=1,3)
      WRITE(*,100)ISEG,(TITL(I),I=1,3)
  100 FORMAT(1X,'THE RESULTS FOR UNIT NUMBER: ',I3,'(',3A4,')')
      WRITE(6,101)TAREA,TRVOL,TVINTR,QT,TYIELD
      WRITE(*,101)TAREA,TRVOL,TVINTR,QT,TYIELD
  101 FORMAT(1X,' THE TOTAL AREA IN ACRES: ',G12.5/,
     +' THE TOTAL RAINFALL IN ACRE FEET: ',G12.5,/,
     +' THE TOTAL INTERCEPTED VOLUME IN ACRE FEET: ',G12.5,/,
     +' THE TOTAL DISCHARGE IN ACRE FEET: ',G12.5,/,
     +' THE TOTAL SEDIMENT YIELD IN POUNDS: ',G12.5///)
      IF (ID.LE.1) THEN
      WRITE(6,110)
      WRITE(*,110)
  110 FORMAT(' (NOTE: THE  FOLLOWING VALUES ARE PER FOOT OF WIDTH',
     +       ' FOR A PLANE UNIT.)')
      ENDIF
      WRITE(6,102)
      WRITE(*,102)
  102 FORMAT(/1X,'THE SEDIMENT YIELD BY SIZES'/
     +'    SIZE IN MM       POUNDS')
      DO 444 ISED=1,NSED
           DMBIOUT = DMBI(ISED)*304.8
           WRITE(6,103) DMBIOUT,YIELD(ISED)
           WRITE(*,103) DMBIOUT,YIELD(ISED)
  444 CONTINUE
  103 FORMAT(1X,G12.5,4X,G12.5)
      WRITE(6,104)
      WRITE(*,104)
  104 FORMAT(////1X,' FINAL HYDROGRAPH'//9X,'TIME'
     +,9X,'DISCHARGE'/8X,'(MIN.)',9X,'(CFS)')
      DO 106 I=2,NUM
        TIME=(I-1)*DTIM/60.
        WRITE(6,105) TIME,Q(I)
        WRITE(*,105) TIME,Q(I)
  105 FORMAT (7X,F8.2,6X,F10.4)
  106 CONTINUE
      RETURN
      END

<cpyr> 5: cat code2
```

```
.MT 6
.PO 12
.OP
      PROGRAM MULTSED3
C
C     THIS IS THE CHANNEL PROGRAM COMPANION TO THE MSED1 UPLAND
C     WATERSHED PROGRAM MSED1.  THIS PROGRAM MAKES A CALL TO
C     A SUBROUTINE CALLED MSED2 WHICH REORDERS THE OUTPUT FROM THE
C     MSED1 PROGRAM SO THAT THEY CAN BE USED IN THIS PROGRAM.
C     THIS PROGRAM WAS ORIGINALLY DEVELOPED AT COLORADO STATE UNI-
C     VERSITY IN THE 1970'S AND HAS SUBSEQUENTLY UNDERGONE MODIFICA-
C     TIONS BY RESEARCHERS AT NEW MEXICO STATE UNIVERSITY AND THE
C     UNIVERSITY OF ILLINOIS.
C          LAST UPDATE: JUNE 1987
C
C     THIS PROGRAM ROUTES WATER AND SEDIMENT FROM UPLAND WATERSHEDS
C     AND ADJACENT CHANNEL SIDE SLOPES THROUGH A CHANNEL NETWORK.
C     A FINITE DIFFERENCE SOLUTION OF THE METHOD OF CHARACTERISTICS
C     FOR A KINEMATIC WAVE ASSUMPTION IS USED.
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PBO(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR6/ NUM,SIN(35,5),TSEDO(35,10),QTOUT(35),TIME(200),
     1              TDDEP(35,5),ITYPE(35)
      COMMON /VAR17/ TSEDEP(35),VCAP(35),VITL(35),VT(35),
     1               GBUPIN(35,10),QIN(35),IFULL(35)
      DIMENSION QSED(10),PPPM(10),SCOUR(35)
      CHARACTER*20 FNAME9
C
C     CALL MSED2 TO SET UP THE DATA FILES FOR THIS PROGRAM
      CALL MSED2
C     GET SOME INFORMATION FOR THIS PROGRAM
      WRITE(*,2000)
      WRITE(*,2001)
      READ(*,2004) FNAME9
 2000 FORMAT(30(/),32X,'WELCOME TO MSED3',/,
     121X,'PC VERSION V87.06 BY TIM J. WARD, NMSU',15(/))
 2001 FORMAT(10X,'WHAT IS THE NAME OF THE MSED3 DATA FILE? '\)
 2004 FORMAT(A)
C
      WRITE(*,2010) FNAME9
 2010 FORMAT(/,20X,'OPENING FILE ',A20,' AS FILE 9',/,
     120X,'OPENING FILE SCREEN3.OUT FOR SCREEN OUTPUT',/,
     220X,'OPENING FILE MSED3.DAT AS FILE 3',/,
     320X,'OPENING FILE MSED4.DAT AS FILE 4',/,
     420X,'OPENING FILE MSED11.OUT AS FILE 11',/,
     520X,'OPENING FILE MSED13.DAT AS FILE 13',/,
     620X,'OPENING FILE MSED14.DAT AS FILE 14',/)
C
      OPEN(6,FILE='SCREEN3.OUT',STATUS='NEW')
      OPEN(11,FILE='MSED11.OUT',STATUS='NEW')
C
```

```
C     GO GET THE DATA
      CALL DATA1(FNAME9)
C     ADJUST THE VISCOSITY
      CALL TEMP
C     INITIALIZE THE UNITS AND VARIABLES
      CALL INITL
      WRITE(11,900)
900   FORMAT(1X,' ISEG          TIME          DISCHARGE       SEDIMENT',
     *          /'           (MINUTES)          (CFS)           (PPM)')
C     GO DO THE WORK
      CALL ROUTE
      REWIND 6
      REWIND 11
      CLOSE(6)
      CLOSE(11)
      STOP '                   MSED3 IS FINISHED'
      END
C
```

```
C     *************************************************************
C
      SUBROUTINE MSED2
C
$LARGE
C     THIS SUBROUTINE REFORMATS THE FILES CREATED BY
C     MSED1 FOR USE BY MSED3
C
      DIMENSION QARRAY(200,70),SDARAY(10,70),QT(70)
      DATA IREAD,IWRIT1,IWRIT2/7,3,4/
C
      WRITE(*,2000)
 2000 FORMAT(15(/),31X,'MSED2 IS RUNNING  ',15(/))
      OPEN(3,FILE='MSED3.DAT',STATUS='NEW')
      OPEN(4,FILE='MSED4.DAT',STATUS='NEW')
      OPEN(7,FILE='MSED7.DAT')
   10 CONTINUE
      WRITE(*,2001) IREAD
 2001 FORMAT('      READING FILE = ',I2/)
      WRITE(*,2002) IWRIT1,IWRIT2
 2002 FORMAT('      WRITING FILES = ',I2,2X,I2///)
      READ(IREAD,100) NU,NUM1
  100 FORMAT(2I10)
      NUM=NUM1-1
      DO 105 I=1,NU
        READ(IREAD,101)NSED
  101 FORMAT(10X,I10)
          READ(IREAD,102)(SDARAY(J,I),J=1,NSED)
  102 FORMAT(4G15.6)
          WRITE(IWRIT2,102)(SDARAY(J,I),J=1,NSED)
          READ(IREAD,102)QT(I)
          READ(IREAD,102)(QARRAY(J,I),J=1,NUM)
  105 CONTINUE
      WRITE(IWRIT1,102)(QT(I),I=1,NU)
      DO 110 J=1,NUM
         WRITE(IWRIT1,102)(QARRAY(J,I),I=1,NU)
  110 CONTINUE
      IF(IREAD.EQ.8) GO TO 200
      IREAD=8
      IWRIT1=14
      IWRIT2=13
      REWIND 3
      REWIND 4
      REWIND 7
      CLOSE(3)
      CLOSE(4)
      CLOSE(7)
      OPEN(8,FILE='MSED8.DAT')
      OPEN(13,FILE='MSED13.DAT',STATUS='NEW')
      OPEN(14,FILE='MSED14.DAT',STATUS='NEW')
      GO TO 10
  200 CONTINUE
      REWIND 8
      REWIND 13
```

```
      REWIND 14
      CLOSE(8)
      CLOSE(13)
      CLOSE(14)
      END
C
```

```
C       *****************************************************************
C
        SUBROUTINE DATA1(FNAME9)
C
C       THIS IS WHERE THE DATA ARE READ INTO THE PROGRAM
C
        COMMON /VAR1/ NSEG.NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
        COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
       1              PB0(35,10),DNB(35,10),WET K(35),POROS(35),
       2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
        COMMON /VAR3/ ISEG(35),IWS(35,3),IPL(35,2),IUP(35,3)
        COMMON /VAR4/ ACB(35),BEX(35),ADF(35),DELTS(35)
        COMMON /VAR5/ VISCO(35),T(35)
        COMMON /VAR6/ NUM,SIN(35,5),TSEDO(35,10),QTOUT(35),TIME(200),
       1              TDDEP(35,5),ITYPE(35)
        COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
        COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
        COMMON /VAR10/CPR,EPR,ALAT,QLAT,A1(35),B1(35),A2(35),B2(35)
        COMMON /VAR15/ QWS(35),QPL(70),QTWS(35),QTPL(70),SEDPL(70,10),
       1               SEDWS(35,10),GBOWS(35,10),GBOPL(70,10)
        COMMON /VAR16/ XN(35)
        COMMON /VAR17/ TSEDEP(35),VCAP(35),VITL(35),VT(35),
       1               GBUPIN(35,10),QIN(35),IFULL(35)
        COMMON /VAR18/ PLASI(35),COHM(35)
        DIMENSION TITLE(20),PF(35,11),D(35,11)
        CHARACTER*20 FNAME9
C
        OPEN(9,FILE=FNAME9,STATUS='OLD')
C
C       INPUT AND OUTPUT TITLE
        READ(9,110)(TITLE(II),II=1,18)
  110   FORMAT(20A4)
        WRITE(11,115,ERR=1)(TITLE(II),II=1,18)
  115   FORMAT(' TITLE: ',20A4)
           READ(9,150) DTIM,FTIM
            NUM=IFIX(FTIM/DTIM+.00001)
C       READ IN THE CHANNEL AND RESERVOIR INDICES
           READ(9,140) NPL,NWS,NRES,NCH,NSED
  140   FORMAT(8I10)
C       SET THE MAXIMUM NUMBER OF ITERATIONS IN WROUT
C       AND THE NUMBER OF SECTIONS THAT THE CHANNEL IS TO
C       DIVIDED INTO FOR ROUTING.
            IMAX=20
            NDX=5
            MM=NSED-1
            NSEG=NCH+NRES
            EPS=.01
            DT=DTIM
          DO 142 I=1,NSEG
            READ(9,145) ISEG(I),IWS(I,1),IWS(I,2),IWS(I,3),IPL(I,1),
       1    IPL(I,2),IUP(I,1),IUP(I,2),IUP(I,3)
  142     CONTINUE
  145   FORMAT (10I5)
            DO 200 I=1,NSEG
```

```
              READ(9,160) ITYPE(I)
  160         FORMAT(//I10)
             IF(ITYPE(I).EQ.1) THEN
C     THIS IS FOR THE CHANNEL UNITS
              READ(9,150) SLEN(I),SLOP1(I),WET K(I),POROS(I),
     +                    SI(I),SW(I),SUC(I),PLASI(I)
              READ(9,150) XN(I),T(I),COHM(I)
              READ(9,150) A1(I),B1(I),A2(I),B2(I),ADF(I)
C     SET THE TWO MPM PARAMETERS AND SHIELDS' COEFFICIENT TO CONSTANTS
              AGB(I) = 0.056
              BEX(I) = 1.5
              DELTS(I) = 0.047
              DO 180 J=1,NSED
                  READ(9,150) D(I,J),PF(I,J)
  180         CONTINUE
             ELSE
C     THIS IS FOR THE RESERVOIR UNITS
              READ(9,150) VCAP(I),VITL(I),SAREA(I),POROS(I)
              VCAP(I)=VCAP(I)*43560.
              VITL(I)=VITL(I)*43560.
              SAREA(I)=SAREA(I)*43560.
              DO 187 J=1,NSED
                  READ(9,150) D(I,J)
  187         CONTINUE
             ENDIF
  150 FORMAT(8F10.0)
          DO 185 J=1,MM
              IF(ITYPE(I).EQ.1) PBO(I,J)=ABS(PF(I,J+1)-PF(I,J))
              DNB(I,J)=(D(I,J+1)*D(I,J))**.5
  185     CONTINUE
  200 CONTINUE
      CLOSE(9)
      IF(NPL.EQ.0) GO TO 213
      OPEN(3,FILE='MSED3.DAT')
      OPEN(4,FILE='MSED4.DAT')
      DO 211 I=1,NPL
      READ(4,300)(SEDPL(I,JJ),JJ=1,MM)
  211 CONTINUE
      READ(3,300)(QTPL(I),I=1,NPL)
  300 FORMAT(4G15.6)
      CLOSE(4)
  213 CONTINUE
      IF(NWS.EQ.0) GO TO 214
      OPEN(13,FILE='MSED13.DAT')
      OPEN(14,FILE='MSED14.DAT')
      DO 212 I=1,NWS
      READ(13,300)(SEDWS(I,JJ),JJ=1,MM)
  212 CONTINUE
      READ(14,300)(QTWS(I),I=1,NWS)
      CLOSE(13)
  214 CONTINUE
      RETURN
1     STOP '     ********** ERROR ON WRITE TITLE **********'
      END

C
```

```
C     ************************************************************
C
      SUBROUTINE TEMP
C
C ---  THIS SUBROUTINE CORRECTS THE VISCOSITY AND
C ---  HYDRAULIC CONDUCTIVITY FOR TEMPERATURE VARIATIONS
C ---  FROM THE ASSUMED TEMPERATURE OF 68 DEGREES (F).
C ---  PARAMETER DEFINTIONS.
C        T      = TEMPERATURE IN DEGREES F.
C        VISCO  = KINEMATIC VISCOSITY (FT**2/SEC)
C        IPLANE = NUMBER OF PLANES.
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PB0(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR5/ VISCO(35),T(35)
      DIMENSION TE(10),V(10)
      DATA TE/32.,40.,50.,60.,68.,80.,90.,100.,120.,140./,
     1     V/1.93,1.66,1.41,1.22,1.09,0.930,0.826,0.739,0.609,0.514/
C
C ---  CALCULATE NEW VISCOSITY BY INTERPOLATION.
      DO 110 K=1,NSEG
      DO 100 I=1,10
        IF(TE(I).LT.T(K)) GO TO 100
        FAC1=(T(K)-TE(I-1))/(TE(I)-TE(I-1))
        VISCO(K)=V(I-1)+FAC1*(V(I)-V(I-1))
        GO TO 110
  100 CONTINUE
  110 CONTINUE
C ---  ADJUST THE HYDRAULIC CONDUCTIVITY.
      DO 101 K=1,NSEG
   10   FAC2=VISCO(K)/1.09
        WET K(K)=WET K(K)/FAC2
        VISCO(K)=VISCO(K)*.00001
  101 CONTINUE
      RETURN
      END
C
```

```
C     ****************************************************************
C
      SUBROUTINE INITL
C
C     THIS SUBROUTINE IS USED TO INITIALIZE THE VARIABLES AND SET UP
C     THE CORRECT UNITS FOR FURTHER COMPUTATIONS
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PB0(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR3/ ISEG(35),IWS(35,3),IPL(35,2),IUP(35,3)
      COMMON /VAR4/ AGB(35),BEX(35),ADF(35),DELTS(35)
      COMMON /VAR5/ VISCO(35),T(35)
      COMMON /VAR6/ NUM,SIN(35,5),TSEDO(35,10),QTOUT(35),TIME(200),
     1              TDDEP(35,5),ITYPE(35)
      COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
     1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      COMMON /VAR17/ TSEDEP(35),VCAP(35),VITL(35),VT(35),
     1               GBUPIN(35,10),QIN(35),IFULL(35)
C
C     INITIALIZE ENTIRE WATERSHED
      ITCOM1=NUM
      DO 100 M=1,MM
      EGB(M)=0.
      GBC(M)=0.
      ZBL(M)=0.
      BTEM(M)=0.
  100 CONTINUE
      DO 300 N=1,NSEG
      DX(N)=SLEN(N)/5.
      QIN(N)=0.0
      IFULL(N)=0
      TSEDEP(N)=0.0
      IF(ITYPE(N).EQ.2) VT(N)=VITL(N)
      Q(N)=0.
      IF(ITYPE(N).EQ.1)WET K(N)=WET K(N)/43200.
      QTOUT(N)=0.
      QDUM(N)=0.
      DO 300 J=1,NDX
      GBUPIN(N,M)=0.0
      A(N,J)=0.
      QP(N,J)=0.
      SIN(N,J)=0.
      IF(ITYPE(N).EQ.1)SLOP(N,J)=SLOP1(N)
      TDDEP(N,J)=0.
      DO 300 M=1,MM
      GBO(N,M)=0.
      TSEDO(N,M)=0.
      SB(N,J,M)=0.
      RB(N,J,M)=0.
  300 CONTINUE
```

```
C     CONVERT SEDIMENT SIZES, FIND FALL VELOCITIES AND MAXIMUM
C     PARTICLE SIZE, AND CALCULATE FRACTION OF THE SOIL THAT IS SOLID.
      DO 106 N=1,NSEG
      DO 104 M=1,MM
      DMB(N,M)=DNB(N,M)/304.8
      IF (DMB(N,M) .LE. 0.0002) THEN
         VFALL(N,M)=2.9517*DMB(N,M)**2/VISCO(N)
      ELSE
      VFALL(N,M)=(SQRT(36.064*DMB(N,M)**3+36.*VISCO(N)**2)-6.*VISCO(N))
     1             /DMB(N,M)
      ENDIF
  104 CONTINUE
       DMAX(N)=DMB(N,MM)
       PORB(N)=1.-POROS(N)
  106 CONTINUE
      RETURN
      END
C
```

```
C     ************************************************************
C
      SUBROUTINE ROUTE
C
C     THIS IS THE SUBROUTINE THAT DOES ALL OF THE WORK.
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PB0(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR3/ ISEG(35),IWS(35,3),IPL(35,2),IUP(35,3)
      COMMON /VAR4/ AGB(35),BEX(35),ADF(35),DELTS(35)
      COMMON /VAR5/ VISCO(35),T(35)
      COMMON /VAR6/ NUM,SIN(35,5),TSEDO(35,10),QTOUT(35),TIME(200),
     1              TDDEP(35,5),ITYPE(35)
      COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
     1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      COMMON /VAR10/ CPR,EPR,ALAT,QLAT,A1(35),B1(35),A2(35),B2(35)
      COMMON /VAR16/ XN(35)
      DIMENSION QSED(10),PPPM(10)
C
      DTS=DT*60.
      DTN=DTS*FLOAT(NDX)
      ITCOM1=NUM
      DO 100 IT=1,ITCOM1
C     IF APPROPRIATE, READ FILES FROM MSED1
      IF(NWS.GE.1.OR.NPL.GE.1)CALL DATA2
      TIME(IT)=FLOAT(IT)*DT
C     COMPUTE AT TIME IT (T+DT)
      DO 200 I=1,NSEG
         K=ISEG(I)
         WRITE(*,2001) I,IT
 2001    FORMAT(2X,'SEGMENT= ',I5,5X,'TIME STEP= ',I5)
          IF(ITYPE(K).EQ.2) THEN
           CALL RES(K,QUP,DTS)
           Q(K)=QUP
           GO TO 311
          ENDIF
      CPR=A1(K)
      EPR=B1(K)
      DTX=DTN/SLEN(K)
C     DETERMINE THE UPSTREAM AND LATERAL CHANNEL INFLOWS
      CALL UPLAT (K,DTS,SLEN(K),QUP)
      DO 300 J=1,NDX
      BPER=A2(K)
      ZSUM=0.
      SLP=SLOP(K,J)
      DO 310 M=1,MM
      ZBL(M)=SB(K,J,M)
      ZSUM=ZSUM+ZBL(M)
      BTEM(M)=RB(K,J,M)
  310 CONTINUE
```

```
      QCONC=QUP+QLAT*SLEN(K)/NDX
      QLATP = QLAT
C     IF SOME WATER IS PRESENT, TRY TO INFILTRATE IT
      IF(A(K,J).GT.1.0E-04) CALL CHINL(K,SIN(K,J),QUP,DTS,A(K,J),QLATP)
      ALAT=QLATP*DTS
      ASUM=ALAT+A(K,J)+DTX*QUP
C     DETERMINE THE COEFFICIENT AND THE EXPONENT IN A-Q RELATION
      CALL RESIST(XN(K),A1(K),B1(K),SLP,ALP,BET)
      IF(ASUM.LE. 1.0E-05) GO TO 320
C     IF WE HAVE SOME WATER LEFT, ROUTE IT IN THE CHANNEL
      CALL WROUT (K,J,DTX,ALP,BET,QUP,QE)
      IF(QE.LE.0.01) GO TO 320
C     REDISTRIBUTE THE SEDIMENT IN THE CHANNEL
      CALL PERTG(K)
C     IF WE STILL HAVE ENOUGH FLOW TO USE, TRANSPORT SOME SEDIMENT
C     AND ROUTE IT THROUGH THE CHANNEL
      CALL TRANSP (K,J,BPER,SLP,QE,AREA,ALP,BET,DC,DCOH)
      CALL SROUT (K,J,DTX,BPER,AREA,QE,DC,QCONC,DCOH)
      GO TO 350
C     IF NO MORE (NOT MUCH) WATER, TAKE CARE OF THE ROUTING IN CEASE
  320 CALL CEASE (K,J,DTX,QUP,QE,AREA)
  350 A(K,J)=ALP*QE**BET
            QP(K,J)=QE
            QUP=QE
      SUMV=0.
      DO 390 M=1,MM
      GBUP(M)=RB(K,J,M)*QE
      SB(K,J,M)=ZBL(M)+EGB(M)/BPER
      GBO(K,M)=GBUP(M)
      SUMV=SUMV+EGB(M)
  390 CONTINUE
      DDEP(J)=SUMV/(PORB(K)*BPER)
      TDDEP(K,J)=TDDEP(K,J)+DDEP(J)
  300 CONTINUE
         Q(K)=QUP
  311     CONTINUE
      IF(K.EQ.NSEG)QOUT(IT)=QUP
      GBOSUM=0.0
      DO 433 M=1,MM
         GBOSUM=GBOSUM+GBO(K,M)*2.65
  433 CONTINUE
      PPM=0.
      DO 312 M=1,MM
          QSED(M)=GBO(K,M)*165.4*DTS
          PPPM(M)=0.0
          IF(QUP.GT.0.0)PPPM(M)=GBO(K,M)*2650000./(QUP+GBOSUM)
          PPM=PPM+PPPM(M)
  312 CONTINUE
      CALL OUT(K,QSED,QUP,PPM,PPPM,IT,ITCOM1,DTS)
  200 CONTINUE
  100 CONTINUE
      RETURN
      END
C
```

```
C     ****************************************************************
C
      SUBROUTINE DATA2
C
C     THIS SUBROUTINE IS USED TO READ DATA FILES CREATED BY MSED1
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR15/ QWS(35),QPL(70),QTWS(35),QTPL(70),SEDPL(70,10),
     1               SEDWS(35,10),GBOWS(35,10),GBOPL(70,10)
C
      IF(NWS.LE.0) GO TO 120
      READ(14,100)(QWS(I),I=1,NWS)
  100 FORMAT(4G15.6)
      DO 110 I=1,NWS
          DO 110 JJ=1,MM
              IF (QTWS(I).LE.0.0) THEN
                 GBOWS(I,JJ)=0.0
              ELSE
                 GBOWS(I,JJ)=SEDWS(I,JJ)*QWS(I)/(QTWS(I)*43560.*165.4)
              ENDIF
  110 CONTINUE
  120         CONTINUE
      IF(NPL.LE.0) RETURN
      READ(3,100)(QPL(I),I=1,NPL)
      DO 200 I=1,NPL
          DO 200 JJ=1,MM
              IF(QTPL(I).LE.0.0) THEN
                GBOPL(I,JJ)=0.0
              ELSE
                GBOPL(I,JJ)=SEDPL(I,JJ)*QPL(I)/(QTPL(I)*43560.*165.4)
              ENDIF
  200 CONTINUE
      RETURN
      END
C
```

```
C     ***************************************************************
C
      SUBROUTINE RES(K,QUP,DTS)
C
C     THIS SUBROUTINE IS USED TO MOVE WATER AND SEDIMENT THROUGH
C     A RESERVOIR UNIT.  THE RESERVOIR WILL FILL THEN SPILL AT THE
C     SAME RATE THAT WATER ENTERS.  SEDIMENT WILL BE TRAPPED ACCORDING
C     TO TRPEF.  MORE EFFORT NEEDS TO BE EXPENDED ON THIS SUBROUTINE
C
      DIMENSION GBUPAV(10),QINPRE(35),GBUPRE(35,10)
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEC(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PBO(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
     1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      COMMON /VAR17/ TSEDEP(35),VCAP(35),VITL(35),VT(35),
     1               GBUPIN(35,10),QIN(35),IFULL(35)
C
      QINPRE(K)=QIN(K)
C     FIND THE UPSTREAM INFLOW TO THE RESERVOIR
      CALL UPRES(K,QUP)
      QIN(K)=QUP
      QAV=(QINPRE(K)+QIN(K))/2.
      DO 100 M=1,MM
          GBUPRE(K,M)=GBUPIN(K,M)
          GBUPIN(K,M)=GBUP(M)
          GBUPAV(M)=(GBUP(M)+GBUPRE(K,M))/2.
  100 CONTINUE
      VIN=QAV*DTS
      VT(K)=VT(K)+VIN
      IF(VT(K).LT.VCAP(K)) GO TO 400
      IFULL(K)=IFULL(K)+1
      QUP=QAV
      IF(IFULL(K).GE.2) GO TO 200
      QUP=(VT(K)-VCAP(K))/DTS
  200 CONTINUE
      VOVFL=1.5*QUP/SAREA(K)
      IF(VOVFL.LE.0.0) GO TO 400
      DO 300 M=1,MM
          TRPEF=VFALL(K,M)/VOVFL
          IF(TRPEF.GT.1.0)TRPEF=1.0
          GBO(K,M)=(1.-TRPEF)*GBUPAV(M)*QUP/QAV
          SEDDEP=(GBUPAV(M)-GBO(K,M))*DTS
          TSEDEP(K)=TSEDEP(K)+SEDDEP/(43560.*PORB(K))
  300 CONTINUE
      RETURN
  400 CONTINUE
      QUP=0.0
      DO 500 M=1,MM
          GBO(K,M)=0.0
          SEDDEP=(GBUPAV(M)-GBO(K,M))*DTS
```

```
          TSEDEP(K)=TSEDEP(K)+SEDDEP/(43560.*PORB(K))
  500 CONTINUE
      RETURN
      END
C
```

```
C      ****************************************************************************
C
      SUBROUTINE UPRES(K,QUP)
C
C     THIS SUBROUTINE IS USED TO FIND THE UPSTREAM
C     INFLOWS TO A RESERVOIR UNIT.
C
      COMMON /VAR1/ NSEC,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR3/ ISEC(35),IWS(35,3),IPL(35,2),IUP(35,3)
      COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
     1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR15/ QWS(35),QPL(70),QTWS(35),QTPL(70),SEDPL(70,10),
     1               SEDWS(35,10),GBOWS(35,10),GBOPL(70,10)
      COMMON /VAR17/ TSEDEP(35),VCAP(35),VITL(35),VT(35),
     1               GBUPIN(35,10),QIN(35),IFULL(35)
C
      QUP=0.
      DO 101 M=1,MM
          GBUP(M)=0.0
  101 CONTINUE
  200 FORMAT(/F10.0)
  210 FORMAT(8F10.0)
      DO 100 J=1,3
          IF(IUP(K,J).EQ.0) GO TO 105
        JJ=IUP(K,J)
         QUP=QUP+Q(JJ)
        DO 100 M=1,MM
          GBUP(M)=GBUP(M)+GBO(JJ,M)
  100 CONTINUE
  105 CONTINUE
      DO 110 J=1,3
         IF(IWS(K,J).EQ.0) GO TO 115
         JJ=IWS(K,J)
         QUP=QUP+QWS(JJ)
         DO 110 M=1,MM
           GBUP(M)=GBUP(M)+GBOWS(JJ,M)
  110 CONTINUE
  115 CONTINUE
      RETURN
      END
C
```

```
C      ***************************************************************
C
       SUBROUTINE UPLAT (K,DTS,SLEN,QUP)
C
C      THIS SUBROUTINE DETERMINES THE UPSTREAM AND LATERAL INFLOW
C      TO A CHANNEL UNIT.
C
       COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
       COMMON /VAR3/ ISEG(35),IWS(35,3),IPL(35,2),IUP(35,3)
       COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
      1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
       COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
       COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
       COMMON /VAR10/ CPR,EPR,ALAT,QLAT,A1(35),B1(35),A2(35),B2(35)
       COMMON /VAR15/ QWS(35),QPL(70),QTWS(35),QTPL(70),SEDPL(70,10),
      1               SEDWS(35,10),GBOWS(35,10),GBOPL(70,10)
C
          QUP=0.
          QLAT=0.
          ALAT=0.
C      DETERMINE THE UPSTREAM INFLOW RATE
       DO 11 I=1,MM
       BLAT(I)=0.
       GBUP(I)=0.
       GBLAT(I)=0.
    11 CONTINUE
       DO 109 J=1, 3
         IF (IUP(K,J) .EQ. 0) GO TO 109
           JJ=IUP(K,J)
           QUP=QUP+Q(JJ)
          DO 108 M=1,MM
           GBUP(M)=GBUP(M)+GBO(JJ,M)
   108    CONTINUE
   109 CONTINUE
       DO 110 J=1,3
           IF(IWS(K,J).EQ.0) GO TO 111
            JJ=IWS(K,J)
            QUP=QUP+QWS(JJ)
           DO 110 M=1,MM
              GBUP(M)=GBUP(M)+GBOWS(JJ,M)
   110     CONTINUE
   111 CONTINUE
C      DETERMINE THE LATERAL INFLOW RATE
       DO 113 J=1, 2
       IF(IPL(K,J).EQ.0) GO TO 113
            JJ=IPL(K,J)
            QLAT=QLAT+QPL(JJ)
           DO 112 I=1,MM
              GBLAT(I)=GBLAT(I)+GBOPL(JJ,I)*SLEN
              BLAT(I)=GBLAT(I)*DTS
   112     CONTINUE
   113 CONTINUE
   200 FORMAT(/F10.0)
   210 FORMAT(8F10.0)
```

```
      RETURN
      END
C
```

```
C     ****************************************************************
C
      SUBROUTINE CHINL(K,SIN,QUP,DTS,AREA,QLATP)
C
C ---  THIS SUBROUTINE CALCULATES CHANNEL INFILTRATION.
C ---  PARMETER DEFINITIONS.
C        SI      = INITIAL SATURATION OF CHANNEL SOIL.
C        SW      = WETTED SATURATION OF CHANNEL SOIL.
C        SUC     = AVERAGE SUCTION OF CHANNEL SOIL (INCHES).
C        POROS   = POROSITY OF SOIL.
C        WET K   = HYDRAULIC CONDUCTIVITY OF CHANNEL SOIL (IN/HR).
C        SIN     = ACCUMALATED INFILTRATED VOLUME (FT**3).
C        QUP     = UPSTREAM FLOW (CFS).
C        QLATP   = LATERAL INFLOW (CFS/FT).
C        DTIM    = LENGTH OF TIME INTERVAL (SEC).
C        AREA    = PREVIOUS CROSS SECTIONAL AREA (FT**2).
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PB0(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      COMMON /VAR10/ CPR,EPR,ALAT,QLAT,A1(35),B1(35),A2(35),B2(35)
C
C ---  GO BACK IF CONDUCTIVITY WAS SET TO 0.0 TO AVOID
C ---  AN INFILTRATING CHANNEL.
       IF(WET K(K).LE.0.0) RETURN
C ---  CALCULATE CHANNEL TOP WIDTH AND DEPTH OF FLOW.
      TW=A2(K)*AREA**B2(K)
      D=AREA/TW
C ---  CALCULATE POTENTIAL INFILTRATION.
      AL=(SUC(K)/12.+D)*(SW(K)-SI(K))*POROS(K)
      C1=2.*SIN-WET K(K)*DTS
      C2=8.*WET K(K)*DTS*(AL+SIN)
      SEGL=SLEN(K)/FLOAT(NDX)
      DELF=((-C1+(C1**2+C2)**.5)/2.)*SEGL*TW
      IF(DELF.EQ.0.0) RETURN
C ---  CALCULATE VOLUME OF AVAILABLE WATER.
      DELV=(QLAT*SEGL+QUP)*DTS
C ---  COMPARE POTENTIAL WITH AVAILABLE.
      IF(DELF.GE.DELV)GO TO 30
      SIN = SIN + DELF/(SEGL*TW)
      QLATP=QLAT-DELF/(SEGL*DTS)
      RETURN
C ---  THIS IS THE CASE WHERE ALL THE AVAILABLE
C ---  WATER IS INFILTRATED.
   30 SIN = SIN + DELV/(SEGL*TW)
      QLATP=0.
      QUP=0.
      RETURN
      END
C
C     ****************************************************************
C
```

```
      SUBROUTINE RESIST(XN,A1,B1,SLP,ALP,BET)
C
C     THIS SUBROUTINE CALCULATES THE PARAMETERS A AND B
C     IN THE EQUATION AREA=A*Q**B.
C
C      ---  THIS IS FOR THE MANNING'S RESISTANCE.
        BET=(3.)/(5.-2.*B1)
        ALP=(A1**(4./3.)*XN**2./(2.21*SLP))**(3./(10.-4.*B1))
      RETURN
      END
C
```

```
C     ***************************************************************
C
      SUBROUTINE WROUT (K,J,DTX,ALP,BET,QUP,QE)
C
C     THIS SUBROUTINE DOES THE KINEMATIC WAVE WATER ROUTING.
C     THE TECHNIQUE ROUTES AREAS (DEPTHS), NOT DISCHARGES.
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      COMMON /VAR10/ CPR,EPR,ALAT,QLAT,A1(35),B1(35),A2(35),B2(35)
C
C     SET UP THE A-Q RELATIONSHIP
            QPRX=QP(K,J)
            QAVE=0.5*(QUP+QPRX)
            BEM=BET-1.
            BEN=BEM-1.
            ALBET=ALP*BET
            ALBEM=ALP*BET*BEM
            DTXA=DTX+ALP
            ERROR=EPS*ASUM
C     LINEAR SCHEME TO FIND THE FIRST APPROXIMATION
            ITER=0
            IF (QAVE.GT.1.0E-5) THEN
              DAQ=ALBET*QAVE**BEM
              QE=(ALAT+DTX*QUP+DAQ*QPRX)/(DTX+DAQ)
            ELSE
              QE=ASUM/DTXA
            ENDIF
C     NONLINEAR SCHEME TO REFINE THE SOLUTION
  115       ITER=ITER+1
            AEST=DTX*QE+ALP*QE**BET
            ADEV=ASUM-AEST
            IF (ABS(ADEV).LE.ERROR) GO TO 120
            IF (ITER.LT.IMAX) GO TO 116
            STOP'     ********** STOPPED IN WROUT **********'
  116       FDER=DTX+ALBET*QE**BEM
            SDER=ALBEM*QE**BEN
            BB=FDER/SDER
            SC=2.*ADEV/SDER
            STEM=BB*BB+SC
            IF (STEM.GE.0.) GO TO 117
            QE=QE+ADEV/FDER
            GO TO 115
  117       STEM=SQRT(STEM)
            IF (ADEV.GT.0.) GO TO 119
            ETEM=BB+STEM
            QE=QE-ETEM
            IF (QE.GT.0.) GO TO 115
  118       ETEM=0.5*ETEM
            QE=QE+ETEM
            IF (QE.GT.0.) GO TO 115
            GO TO 118
  119       X1=QE-BB-STEM
```

```
      X2=QE-BB+STEM
      AD1=ABS(ASUM-DTX*X1-ALP*X1**BET)
      AD2=ABS(ASUM-DTX*X2-ALP*X2**BET)
      QE=X1
      IF (AD1.GT.AD2) QE=X2
      GO TO 115
  120 RETURN
      END
C
```

```
C     ************************************************************
C
      SUBROUTINE PERTG(K)
C
C     THIS SUBROUTINE IS USED TO REDISTRIBUTE THE SEDIMENT
C     IN THE STREAM AS IT IS DEPOSITED OR ERODED.
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PB0(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
     1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      DIMENSION ZB(100)
C
      SSUM=0.
      DO 100 M=1,MM
      ZB(M)=ZBL(M)
      SSUM=SSUM+ZB(M)
  100 CONTINUE
      IF(SSUM.LE.0.0) GO TO 105
      DO 104 M=1,MM
      PB1(K,M)=ZB(M)/SSUM
  104 CONTINUE
      RETURN
  105 CONTINUE
      DO 106 M=1,MM
        PB1(K,M)=PB0(K,M)
  106 CONTINUE
      RETURN
      END
C
```

```
C     **************************************************************
C
      SUBROUTINE TRANSP (K,J,BPER,SLP,QE,AREA,ALP,BET,DC,DCOH)
C
C     THIS SUBROUTINE IS USED TO DETERMINE THE SEDIMENT TRANSPORT
C     CAPACTIY IN THE CHANNEL BASED ON THE MEYER-PETER, MULLER
C     BED LOAD EQUATION AND EINSTEIN'S SUSPENDED LOAD EQUATION.
C     TRANSPORT CAPACITY IS DETERMINED FOR EACH PARTICLE SIZE.
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PB0(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR3/ ISEG(35),IWS(35,3),IPL(35,2),IUP(35,3)
      COMMON /VAR4/ AGB(35),BEX(35),ADF(35),DELTS(35)
      COMMON /VAR5/ VISCO(35),T(35)
      COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
     1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      COMMON /VAR10/ CPR,EPR,ALAT,QLAT,A1(35),B1(35),A2(35),B2(35)
      COMMON /VAR18/ PLASI(35),COHM(35)

C     DETERMINATION OF FLOW CONDITIONS, SUCH AS HYDRAULIC DEPTH, MEAN
C     VELOCITY, AND BOUNDARY SHEAR STRESS
            AREA=ALP*QE**BET
            WEPER=CPR*AREA**EPR
            HYRAD=AREA/WEPER
            BPER=A2(K)*AREA**B2(K)
            VMEAN=QE/AREA
            TAU=62.4*HYRAD*SLP
C
      IF(PLASI(K).GT.0.0) THEN
         TCOH=0.0022*PLASI(K)**0.82
         ERATE=COHM(K)*(TAU/TCOH-1.)/(62.4*2.65)
         IF(ERATE.LT.0.0) ERATE=0.0
         DCOH=ERATE*DT*60.
      ENDIF
            SV=SQRT(TAU/1.9379)
            BMV=2.5+VMEAN/SV
      DC=0.0
      ICHECK=0
      FMAX=1.5/(1.69+2.*ALOG10(2.*HYRAD/DMB(K,MM)))**2
      IF(FMAX.GT.0.10) FMAX=0.10
      IF(FMAX.LT.0.01) FMAX=0.01
      FMIN=0.50*FMAX
  124 DO 204 M=1,MM
       F=1.5/(1.69+2.*ALOG10(2.*HYRAD/DMB(K,M)))**2
       IF(F.GT.FMAX)F=FMAX
       IF(F.LT.FMIN)F=FMIN
       TAO=.2425*F*VMEAN*VMEAN
       TTEM=TAO-102.96*DELTS(K)*DMB(K,M)
C     BED MATERIAL LOAD COMPUTATION
      IF(TTEM.LE.0.) GO TO 127
```

```
 1210 CONTINUE
C     DETERMINATION OF RATIO OF SUSPENDED BED MATERIAL LOAD
      FVB=VFALL(K,M)
      ZR=FVB/(0.4*SV)
      AR=2.0*DMAX(K)/HYRAD
      SUPMAX=1./AR
      IF( AR .GT. 0.9) GO TO 125
            CALL POWER (ZR,AR,FJ,SJ,1.0E-2)
            P=AR**(ZR-1.)/(11.6*(1.-AR)**ZR)
            SUSP=P*(BMV*FJ+2.5*SJ)
            IF (SUSP.LT.0.) SUSP=0.
            IF(SUSP.GT.SUPMAX) SUSP=SUPMAX
            GO TO 126
  125       SUSP=0.
C     DETERMINATION OF TRANSPORTING CAPACITY FOR BED MATERIAL LOAD
  126 GBC(M)=(1.+SUSP)*WEPER*AGB(K)*TTEM**BEX(K)
      RB(K,J,M)=GBC(M)*PB1(K,M)/QE
      TTMPRE=TTEM
      M1=M
      IF(M.GE.MM)DC=1.1*DMB(K,M)
      GO TO 204
  127 RB(K,J,M)=0.
      GBC(M)=0.0
      ICHECK=ICHECK+1
      IF(ICHECK.GT.1) GO TO 204
      IF(M.LE.1) GO TO 204
      DC=DMB(K,M1)+TTMPRE*(DMB(K,M)-DMB(K,M1))/(TTMPRE-TTEM)
  204 CONTINUE
      RETURN
      END
C
```

```
C     ****************************************************************
C
      SUBROUTINE POWER (Z,A,XJ1,XJ2,CONV)
C
C     THIS SUBROUTINE EVALUATE J1 AND J2 INTEGRALS
C     USED IN THE EINSTEIN SUSPENDED LOAD EQUATION
C     NOTATIONS:
C     XJ1 = VALUE OF J1 INTEGRAL
C     XJ2 = VALUE OF J2 INTEGRAL
C     N = ORDER OF APPROXIMATION + 1
C     CONV = CONVERGENCE CRITERION
C
      N=1
      XJ1=0.
      XJ2=0.
      ALG=ALOG(A)
      C=1.
      D=-Z
      E=D+1.
      FN=1.
      AEX=A**E
      GO TO 102
  101 N=N+1
      C=C*D/FN
      D=E
      E=D+1.
      FN=FLOAT(N)
      AEX=A**E
  102 IF (ABS(E).LE.0.001) GO TO 103
      XJ1=XJ1+C*(1.-AEX)/E
      XJ2=XJ2+C*((AEX-1.)/E**2-AEX*ALG/E)
      GO TO 104
  103 XJ1=XJ1-C*ALG
      XJ2=XJ2-0.5*C*ALG**2
  104 IF (N.EQ.1) GO TO 105
      CJ1=ABS(1.-FJ1/XJ1)
      CJ2=ABS(1.-FJ2/XJ2)
      IF (CJ1.LE.CONV.AND.CJ2.LE.CONV) RETURN
  105 FJ1=XJ1
      FJ2=XJ2
      GO TO 101
      END
C
```

```
C     ****************************************************************
C
      SUBROUTINE SROUT (K,J,DTX,BPER,AREA,QE,DC,QCONC,DCOH)
C
C     THIS IS THE SEDIMENT ROUTING SUBROUTINE.  IN HERE, THE
C     LOAD TRANSPORTED INTO A CHANNEL SECTION IS COMPARED WITH
C     THE TRANSPORT CAPACITY AND WHAT IS AVAILABLE TO MOVE.
C     IF AVAILABLE, THOSE SIZES THAT CAN BE TRANSPORTED WILL BE,
C     WHILE THOSE THAT CANNOT WILL NOT.
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
     1              PBO(35,10),DNB(35,10),WET K(35),POROS(35),
     2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
      COMMON /VAR4/ AGB(35),BEX(35),ADF(35),DELTS(35)
      COMMON /VAR5/ VISCO(35),T(35)
      COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
     1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      COMMON /VAR10/ CPR,EPR,ALAT,QLAT,A1(35),B1(35),A2(35),B2(35)
      COMMON /VAR18/ PLASI(35),COHM(35)
      DIMENSION ZBNEW(10)
C
C     CHECK THE AVAILABILITY OF BED MATERIAL LOAD
      NARM=1
      PARM=1.0
      SGBUP=0.
      SRBE=0.
      SBTEM=0.
      SBLAT=0.
      IF(ZSUM.LT.0.2) GO TO 50
      PARM=0.0
      DO 10 M=1,MM
       M1=MM-M+1
       PARM=PARM+PB1(1,M1)
       IF(PB1(1,M1).LE.0.0) GO TO 10
       NARM=M1
       GO TO 20
   10 CONTINUE
   20 CONTINUE
   50 DO 101 M=NARM,MM
      SGBUP=SGBUP+GBUP(M)
      SRBE=SRBE+RB(K,J,M)
      SBTEM=SBTEM+BTEM(M)
  101 SBLAT=SBLAT+BLAT(M)
      SEGB=(SGBUP-SRBE*QE)*DTX-SRBE*AREA+SBTEM*A(K,J)+SBLAT
      IF(SEGB .GE. 0.) GO TO 102
      EBTEM=SEGB+ZSUM*BPER
      IF(EBTEM .GE. 0.) GO TO 102
      DEP=-ADF(K)*EBTEM/(BPER*PARM)
      IF(DC.GT.DMB(K,M)) GO TO 103
      IF(DC.LE.DMB(K,1))GO TO 102
      PCO=PBO(K,MM)
```

```
      PC1=PB1(K,MM)
      MMM=MM-1
      DO 100 M=1,MMM
          M1=MM-M
          PC0=PC0+PB0(K,M1)
          PC1=PC1+PB1(K,M1)
          IF(DC.LT.DMB(K,M1)) GO TO 100
          FAC=(DC-DMB(K,M1))/(DMB(K,M1+1)-DMB(K,M1))
          PC0=PC0-PB0(K,M1)*FAC
          PC1=PC1-PB1(K,M1)*FAC
          IF(PC1.GT.0.0) GO TO 97
          DEPMAX=ZSUM
          GO TO 98
   97     DEPMAX=2.*DC/PC1
   98     IF(DEPMAX.LT.ZSUM) GO TO 102
          IF(PC0.LE.0.0) GO TO 103
          DEPTEM=(2.*DC-ZSUM*PC1)/PC0
          GO TO 99
  100 CONTINUE
      GO TO 102
   99 IF(DEP.GT.DEPTEM) DEP=DEPTEM
      GO TO 103
  102 DEP=0.0
  103 CONTINUE
      IF(PLASI(K).LE.0.0)GO TO 104
      IF(DEP.GT.DCOH)DEP=DCOH
  104 ZSUM=ZSUM+DEP
      SUM=ZSUM
       IF(SUM.LE.0.0) SUM=SEGB
      IF(SUM.LE.0.0)SUM=.005
C     DETERMINATION OF AVAILABILITY FOR NEXT TIME STEP
      DO 206 M=1,MM
      ZBL(M)=ZBL(M)+DEP*PB0(K,M)
  206 CONTINUE
      DO 306 M=1,MM
      ZBNEW(M)=(ZBL(M)*BPER+GBUP(M)*DTX+BTEM(M)*A(K,J)+BLAT(M))
     1/(BPER+(GBC(M)/SUM)*(DTX+AREA/QE))
  305 RB(K,J,M)=ZBNEW(M)*GBC(M)/(SUM*QE)
      EGB(M)=(ZBNEW(M)-ZBL(M))*BPER
      IF(EGB(M).LE.0.0) GO TO 306
      IF(QE.LE.5.0) GO TO 306
      FDEP=.5*VFALL(K,M)*BPER*DX(K)/QE
      IF(FDEP.GT.1.0) GO TO 306
      RBN=(1.-FDEP)*(GBUP(M)+BLAT(M)/DTX)/QCONC
      IF(RBN.LE.RB(K,J,M)) GO TO 306
      RBMAX=.99*(GBUP(M)*DTX+A(K,J)*BTEM(M)+BLAT(M))/(QE*DTX+AREA)
      IF(RBN.GT.RBMAX)RBN=RBMAX
      RB(K,J,M)=RBN
      EGB(M)=(GBUP(M)-RB(K,J,M)*QE)*DTX-AREA*RB(K,J,M)
     1     +A(K,J)*BTEM(M)+BLAT(M)
  306 CONTINUE
      RETURN
      END
C
```

```
C     ***************************************************************
C
      SUBROUTINE CEASE (K,J,DTX,QUP,QE,AREA)
C
C     THIS SUBROUTINE IS USED TO ACCOUNT FOR THE FLOW AFTER
C     THE LATERAL INFLOW HAS ENDED.  SEDIMENT FLOWS ARE ZEROED.
C
      COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
      COMMON /VAR4/ AGB(35),BEX(35),ADF(35),DELTS(35)
      COMMON /VAR7/ EGB(35),GBC(35),ZBL(35),GBUP(35),GBLAT(35),BLAT(35),
     1              BTEM(35),SB(35,5,10),RB(35,5,10),SLOP(35,5),DDEP(5)
      COMMON /VAR8/ A(35,10),Q(100),QP(35,10),PB1(35,10),GBO(35,10)
      COMMON /VAR9/ PORB(35),ZSUM,ASUM,EPS,DT,DX(50),DMAX(35)
      COMMON /VAR10/ CPR,EPR,ALAT,QLAT,A1(35),B1(35),A2(35),B2(35)
C
            AREA=0.
            QE=0.
      DO 360 M=1,MM
        EGB(M)=GBUP(M)*DTX+BTEM(M)*A(K,J)+BLAT(M)
        RB(K,J,M)=0.
  360 CONTINUE
      RETURN
      END
C
```

```
C      ***************************************************************************
C
       SUBROUTINE OUT (K,QSED,QUP,PPM,PPPM,IT,ITCOM1,DTS)
C
C      THIS SUBROUTINE HANDLES THE OUTPUT OF THE RESULTS.
C      ONLY THE RESULTS AT THE LAST COMPUTED UNIT ARE
C      WRITTEN TO SCREEN11.OUT. THE OTHER RESULTS ARE
C      WRITTEN TO FILE11 (MSED11.OUT) AFTER EACH TIME INTERVAL.
C
       COMMON /VAR1/ NSEG,NWS,NPL,NDX,IMAX,MM,QOUT(200),QDUM(35)
       COMMON /VAR2/ SEG(35),SLEN(35),SLOP1(35),DMB(35,10),
      1              PB0(35,10),DNB(35,10),WET K(35),POROS(35),
      2              SI(35),SW(35),SUC(35),VFALL(35,10),SAREA(35)
       COMMON /VAR6/ NUM,SIN(35,5),TSEDO(35,10),QTOUT(35),TIME(200),
      1              TDDEP(35,5),ITYPE(35)
       COMMON /VAR17/ TSEDEP(35),VCAP(35),VITL(35),VT(35),
      1               GBUPIN(35,10),QIN(35),IFULL(35)
       DIMENSION QSED(10),PPPM(10),SCOUR(35)
C
           QTOUT(K)=QTOUT(K)+(QDUM(K)+QUP)*.5*DTS/43560.
           WRITE(11,200,ERR=1)K,TIME(IT),QUP,PPM
           WRITE(11,210,ERR=1)(PPPM(M),M=1,MM)
 210       FORMAT(1X,' PPM BY SIZES : ',5(1X,F8.0)/16X,5(1X,F8.0))
 200   FORMAT(3X,I2,5X,F8.2,5X,F10.2,5X,F10.2)
       TSPRT = 0.0
       DO 300 M=1,MM
           TSEDO(K,M)=TSEDO(K,M)+QSED(M)
           IF(K.EQ.NSEG) TSPRT = TSPRT + TSEDO(K,M)
 300   CONTINUE
       QDUM(K)=QUP
       IF(K.NE.NSEG.OR.IT.NE.ITCOM1) RETURN
       WRITE(11,350,ERR=1)
 350   FORMAT(//,' THE FOLLOWING ARE SEDIMENT YIELDS BY SIZE FRACTIONS',
      1     /,' WITH THE SMALLEST SIZE FIRST AND THE LARGEST LAST.',/)
       DO 360 J=1,K
           WRITE(11,351,ERR=1) J
           WRITE(11,352,ERR=1)(TSEDO(J,M),M=1,MM)
           IF(ITYPE(J).EQ.2) GO TO 360
           SCOUR(J)=0.0
           DO 359 JJ=1,NDX
               SCOUR(J)=SCOUR(J)+TDDEP(J,JJ)/NDX
 359   CONTINUE
 360   CONTINUE
 351   FORMAT(/,' THE YIELDS FOR UNIT ',I2,' IN POUNDS.')
 352   FORMAT(5(1X,G15.7)/5(1X,G15.7))
       WRITE(11,370,ERR=1)
 370   FORMAT(//,' THE FOLLOWING RESULTS DISPLAY THE AMOUNT OF SEDIMENT'
      1       ,/,' DEPOSITED OR REMOVED FROM THE CHANNELS AND RESERVOIRS.'
      2       ,/,' IN THE CASE OF A CHANNEL THE NUMBER REPRESENTS THE '
      3       ,/,' DEPTH OF DEGRADATION OR AGGRADATION. FOR A RESEVOIR IT'
      4       ,/,' REPRESENTS THE VOLUME OF SEDIMENT DEPOSITED WITH POR-'
      5       ,/,' OSITY TAKEN INTO ACCOUNT.',/)
       DO 390 J=1,K
           IF(ITYPE(J).EQ.1) WRITE(11,381,ERR=1)J,SCOUR(J)
```

```
        IF(ITYPE(J).EQ.2) WRITE(11,382,ERR=1)J,TSEDEP(J)
  390 CONTINUE
  381 FORMAT(1X,' FOR CHANNEL NO. ',I2,' THE CHANGE IN ELEVATION =',
     1G15.7,' FEET.')
  382 FORMAT(' FOR RESERVOIR NO. ',I2,' THE STORED SEDIMENT =',G15.7
     1,' AC-FT.')
      WRITE(11,400,ERR=1)
  400 FORMAT(//' THE FOLLOWING ARE THE WATER YIELDS FOR EACH UNIT.'//)
      WRITE(11,401,ERR=1)(J,QTOUT(J),J=1,NSEG)
  401 FORMAT(/' THE TOTAL WATER YIELD FOR UNIT ',I2,' IS:',G15.7,
     1        'AC-FT.')
      WRITE(*,500) NSEG,QTOUT(NSEG),TSPRT
      WRITE(6,500) NSEG,QTOUT(NSEG),TSPRT
  500 FORMAT(10(/),' THE RESULTS FOR THE DOWNSTREAM OUTLET'
     1            ,' OF THE WATERSHED, UNIT =',I3,
     2           //' THE TOTAL RUNOFF IN ACRE FEET: ',G12.5,
     3            /' THE TOTAL SEDIMENT YIELD IN POUNDS: ',G12.5,
     4           //' THE SEDIMENT YIELD BY SIZES:',
     5           //'    SIZE IN MM      POUNDS')
      DO 444 M=1,MM
            DMBIOUT = DNB(NSEG,M)
            WRITE(*,510)  DMBIOUT,TSEDO(NSEG,M)
            WRITE(6,510)  DMBIOUT,TSEDO(NSEG,M)
  444 CONTINUE
  510 FORMAT(1X,G12.5,4X,G12.5)
      WRITE(6,520)
      WRITE(*,520)
  520 FORMAT(//' FINAL HYDROGRAPH'//9X,'TIME',9X,'DISCHARGE'
     1/8X,'(MIN.)',9X,'(CFS)')
      WRITE(*,530) (TIME(I),QOUT(I),I=1,ITCOM1)
      WRITE(6,530) (TIME(I),QOUT(I),I=1,ITCOM1)
  530 FORMAT(7X,F8.2,6X,F10.4)
      RETURN
1     STOP'     ********** STOPPED IN OUT **********'
      END
```

APPENDIX B:

FORMAT OF DATA FILES

Table B1

Input Files for MULTSED

File Name	Program	Information Contained
FILE 1	MSED1	Computational sequence for subwatershed and plane units, time increment, total time of hydrograph, and simulation title All physical parameters for subwatershed and plane units.
FILE 9	MSED3	Computational sequence for channel and reservoirs, time increment, total time of hydrograph, and simulation title (the time parameters must agree with FILE 1). All physical parameters for channel and reservoir units.

Table B2

Format and Contents of FILE 1
Computational Sequence, Plane and Subwatershed Units

Line Number	Columns	Format	Variable Label	Contents
1	1-10	8A10	TITLE	Title of simulation
2	1-10	F10.0	DTIM	Time increment (min)
	11-20	F10.0	FTIM	Total length of simulation (min)
3	1-10	I10	NPL	Number of planes in the watershed
	11-20	I10	NWS	Number of sub-watershed units in the watershed
	(line 4 is repeated for NPL + NWS units)			
4	1-10	I10	ISEG(I)	Segment number for the Ith unit (ISEG(I) must equal I)
	11-20	I10	ITYPE(I)	1 = plane unit, 2 = subwatershed unit
	21-30	I10	IPRINT(I)	If results are to be printed, IPRINT(I) must be positive. If negative, results are not printed.

Table B3

Format and Contents of FILE 1
Physical Parameters for Subwatershed and Plane Units

Line Number	Columns	Format	Variable Label	Contents
5	1-80	-	-	Blank
6	1-80	8A10	-	Title of unit and any other information
7	1-12	3A4	None	Unit identification
	13-22	I10	IPLANE	1 = plane unit 2 = subwatershed unit
		(left plane soil properties)		
8	1-10	F10.0	WETK(1)	Hydraulic conductivity (in./hr)
	11-20	F10.0	POROS(1)	Porosity (decimal fraction)
	21-30	F10.0	SI (1)	Initial soil saturation (decimal fraction)
	31-30	F10.0	SW (1)	Final soil saturation (decimal fraction)
	41-50	F10.0	SAVE(I)	Average capillary suction (in.)
	51-60	F10.0	PLASI(I)	Plasticity index (percent)
	61-70	F10.0	COHM(I)	Erosion rate constant for cohesive soils (lb/ft2-sec)
		(right plane soil properties)		

9 (Same variables as line 4 except for the right side of the subwatershed. If a plane unit is being considered, then this line is blank. The array indices are all 2.)

Table B3 (Cont'd)

Line Number	Columns	Format	Variable Label	Contents
		(left plane vegetative and cover characteristics)		
10	1-10	F10.0	CANCOV(1)	Percent of area with canopy cover
	11-20	F10.0	VC(1)	Potential storage volume per area for canopy cover (in.)
	21-30	F10.0	GRNCOV(1)	Percent of area with ground cover
	31-40	F10.0	VG(1)	Potential ground cover storage volume per area (in.)
	41-50	F10.0	PIMP(1)	Percent of area which has impervious cover
	51-60	F10.0	SLOOSE(1)	Weight of loose soil on the plane (lb) (Usually left blank)
		(right plane vegetative and cover characteristics)		
11	(Same as line 6 except for the right side of the subwatershed. This line is blank if a plane is being considered. The array indices are all 2.)			
12	1-10	F10.0	SLOPE(1)	Overland slope of the left side of a subwatershed or a single plane unit (decimal fraction).
	11-20	F10.0	PLENGTH(1)	Length of overland slope for left plane (ft).

Table B3 (Cont'd)

Line Number	Columns	Format	Variable Label	Contents
	21-30	F10.0	DPRES(1)	Fraction of left plane which does not contribute to flow because of depressions (decimal)
	(This line is blank for a single plane unit)			
13	1-10	F10.0	SLOPE(2)	Overland slope of the right side of a subwatershed unit (decimal fraction)
	11-20	F10.0	PLENGTH(2)	Length of overland slope for the right plane (ft)
	21-30	F10.0	DPRES(2)	Fraction of right plane which does not contribute to flow because of depression (decimal)
14	1-10	F10.0	SLOPE(3)	Channel slope (decimal fraction)
	11-20	F10.0	PLENGTH(3)	Channel length (ft) (Note: This is the neighboring channel unit in the case of a plane.)
15	1-10	I10	NRAIN	Number of rainfall increments
	11-20	F10.0	T	Soil temperature (°F)
	21-30	F10.0	XN	Manning's n for channel (blank if Chezy C is used)

Table B3 (Cont'd)

Line Number	Columns	Format	Variable Label	Contents
	31-40	F10.0	A1	A1 in P = A1*A**B1 (Note: if A1 is 0.0, the triangular approximation is used.)
	41-50	F10.0	B1	B1 in above
	51-60	F10.0	ADW	Maximum resistance parameter for overland flow
	61-70	F10.0	COHM(3)	Erosion rate constant for cohesive soil in subwatershed channels (lb/ft2-sec)
16	1-10	F10.0	RAINOLD(I)	Rainfall intensity (in./hr)
	11-20	F10.0	RAINT(I)	Ending time of rainfall intensity (min)
	(This line is repeated from 1 to NRAIN times)			
	(sediment properties)			
17	1-10	F10.0	DCOEFF	Rainfall splash detachment coefficient
	11-20	F10.0	DOF	Overland flow detachment coefficient
	21-30	F10.0	CHDOF	Channel detachment coefficient (blank if single plane unit)

Table B3 (Cont'd)

Line Number	Columns	Format	Variable Label	Contents
	31-40	F10.0	PLASI(3)	Plasticity index for soil in subwatershed channel (percent)
	41-50	I10	NSED	Number of sediment sizes (this number must be identical for all units)
	(sediment grain size and percentage listed from smallest to largest)			
18	1-10	F10.0	D(I)	Sediment diameter (mm)
	11-20	F10.0	P(I)	Fraction of sediment equal to or finer than this size (decimal)

(This line is repeated from 1 to NSED times.)

The same order of inputs in lines 5 through 18 is followed for the next plane or subwatershed unit.

Table B4

Format and Contents of FILE 9 Computational Sequence, Channel and Reservoir Units

Line Number	Columns	Format	Variable Label	Contents
1	1-80	8A10	TITLE	Title of simulation
2	1-10	F10.0	DTIM	Time increment (min)
	11-20	F10.0	FTIM	Total length of simulation (min)
	(DTIM and FTIM must agree with FILE 1 values)			
3	1-10	I10	NPL	Number of planes (must agree with FILE 1)
	11-20	I10	NWS	Number of sub-watersheds (must agree with FILE 1)
	21-30	I10	NRES	Number of reservoir units
	31-40	I10	NCH	Number of channel units
	41-50	I10	NSED	Number of sediment sizes (must agree with FILE 1)
(computational sequence)				
4	1-5	I5	ISEG(I)	Channel or reservoir identification number [ISEG(I) must equal 1]
	6-20	3I5	IWS(I,J)	Identification number of all subwatershed units that flow into ISEG(I) (maximum of three)

Table B4 (Cont'd)

Line Number	Columns	Format	Variable Label	Contents
	21-30	2I5	IPL(I,J)	Identification number of plane units which flow into ISEG(I) [for the case when ISEG(I) is a reservoir no plane units are allowed]
	31-45	3I5	IUP(I,J)	Identification number of upstream input units which are either channels or reservoirs (these numbers correspond to the ISEG number assigned earlier to the inflowing unit)

Line 4 is repeated for each of the channel and reservoir units (a total of NCH + NRES)

Table B5

Format and Contents of File 9 Physical Parameters for Channel and Reservoir Units

Line Number	Columns	Format	Variable Label	Contents
5	1-80	-	-	Blank
6	1-80	-	-	Channel or reservoir name and other information (this line is not read)
7	1-10	I10	ITYPE(I)	1 = channel, 2 = reservoir unit
(for the case of a channel)				
8	1-10	F10.0	SLEN(I)	Slope length of channel (ft)
	11-20	F10.0	SLOP1(I)	Slope of channel (decimal fraction)
	21-30	F10.0	WETK(I)	Hydraulic conductivity in channel (in./hr)
	31-40	F10.0	POROS(I)	Porosity of channel bed (decimal fraction)
	41-50	F10.0	SI(I)	Initial saturation of channel (decimal fraction)
	51-60	F10.0	SW(I)	Final saturation of channel (decimal fraction)
	61-70	F10.0	SUC(I)	Capillary suction of channel bed (in.)
	71-80	F10.0	PLASI(I)	Plasticity index of channel bed material (percent)

Table B5 (Cont'd)

Line Number	Columns	Format	Variable Label	Contents
		***** When the unit is a reservoir ***** (for the case of a reservoir, note the line number)		
8	1-10	F10.0	VCAP(I)	Storage capacity of reservoir (acre-ft)
	11-20	10.0	VITL(I)	Initial volume stored in reservoir at start of storm (acre-ft)
	21-30	F10.0	SAREA(1)	Surface area of reservoir (acres)
	31-40	F10.0	POROS(1)	Porosity of deposited material
		(for the case of a reservoir)		
9	1-10	F10.0	D(I,J)	Sediment size (mm) (Must agree with size from FILE 1)
	11-20	F10.0	TRPEF(I,J)	Trap efficiency for given sediment size (decimal fraction)

This line is repeated from 1 to NSED times.

Note: For the case of a channel, lines 4-7 are used, but for the case of a reservoir, only 4 and 5. Lines 1-3 are used in both cases and have identical meanings.

Line Number	Columns	Format	Variable Label	Contents
		(for the case of a channel)		
9	1-10	F10.0	XN(I)	Manning's n (blank if Chezy C is used)
	11-20	F10.0	T(I)	Temperature of channel soil (°F)
	21-30	F10.0	COHM(I)	Erosion rate constant for cohesive soils in channel bed (lb/ft2-sec)

Table B5 (Cont'd)

Line Number	Columns	Format	Variable Label	Contents
		(for the case of a channel)		
10	1-10	F10.0	A1(I)	A1 in P=A1*A**B1
	11-20	F10.0	B1(I)	B1 in above
	21-30	F10.0	A2(I)	A2 in T = A2*A**B2
	31-40	F10.0	B2(I)	B2 in above
	41-50	F10.0	ADF(I)	Detachment coefficient for channel bed
		(for the case of a channel)		
11	1-10	F10.0	D(I,J)	Sediment size (mm). (Must agree with sizes from TAPE 1 (listed from smallest to largest)
	11-20	F10.0	PF(I,J)	Fraction of sediment equal to or smaller than given diameter (decimal)

Line 11 line is repeated from 1 to NSED times

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Camp Roberts 93451
ATTN: CACR-DFE

Presidio of Monterey 93940
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ATTN: AFKC-EN

MTMC Western Area 94626
ATTN: SDSSH-AFE-E

Yakima Firing Center 98901
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Lima Tank Plant 45804
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ATTN: DRCIS-RI 61204

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Lemo-Leano User Center 13601
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